

ZOOLOGICAL RESULTS

BASED ON MATERIAL FROM

NEW BRITAIN, NEW GUINEA, LOYALTY
ISLANDS AND ELSEWHERE,

COLLECTED

DURING THE YEARS 1895, 1896 AND 1897,

BY

ARTHUR WILLEY, D.Sc. LOND., HON. M.A. CANTAB.

BALFOUR STUDENT OF THE UNIVERSITY OF CAMBRIDGE.

PART II.

CAMBRIDGE:

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REPORT ON THE SPECIMENS OF THE GENUS MILLEPORA COLLECTED BY DR WILLEY.

By SYDNEY J. HICKSON, M.A., D.Sc., F.R.S.

Beyer Professor of Zoology in the Owens College, Manchester.

With Plates XII—XVI.

THE collection of specimens of *Millepora* brought home by Dr Willey consisted of a few very fine dried specimens, numerous fragments and a number of pieces preserved in spirit. It is of interest as exhibiting another example of the great variation in the form of growth which is a characteristic feature of the genus.

A careful examination of all the dried specimens failed to disclose any ampullae, and in none of the samples of the preserved specimens which I have examined can any trace be found of sexual organs. Many of the specimens are very considerably affected by parasites of various kinds, the details of which are given below.

Some of the specimens are modified in form by being simply thin encrusting plates which have grown over dead corals. In a recently published paper (1898) I have pointed out the evidence that there is for believing that at present only one species of the genus *Millepora* is known. The evidence was obtained from the study of *Millepores* brought from many different reefs in widely separated parts of the world, and, as Dr Willey's collection assisted me materially in the investigation which led to the publication of that paper, it is hardly necessary to repeat that in my opinion all the specimens in his collection belong to the one species *M. alcicornis* Linn.

Some of the specimens however require special description, and the question arises in what manner such specimens can be named without breaking up the genus into artificial groups and calling such groups "species," a plan which in my opinion is misleading, or on the other hand calling the old species "varieties" and thus introducing a trinomial system.

What the author wishes to convey in a word to the reader is the general form of the corallum which he is about to describe so that a mental picture may be formed of the manner of growth of the coral the details of which will be learnt in the text. To those who have studied the genus at all the old specific names as a general rule convey to their minds this feature and this feature only, and it is consequently of value to retain some or all of these names as the one-word description of the form of growth. Instead of repeating therefore at the beginning of the description of each specimen the words "*Millepora alcicornis* of the form of growth

attributed to *Millepora* species by authors," I propose to abbreviate it in each case thus, "*Millepora alcicornis* Facies 'x,'" or simply "Facies x," where "*Millepora alcicornis*" is understood.

The word "Facies" as it will be used will not convey more than the word "Colour" does in the description of species.

When we speak of a horse of black colour no one assumes that we mean a horse belonging to a black coloured species, and similarly when I use the expression "a Coral of dichotomous facies" or of "facies *dichotoma*" I do not mean more than that the particular specimen described happens to be of this form of growth.

MILLEPORA ALCICORNIS.

FACIES *dichotoma*.

There are several pieces of corallum which under the old system would have been included in the species *Millepora dichotoma* (Forsk.)

Forsk. his original definition of this species is as follows, "retiformis, laeviuscula, ramis teretibus, subcompressis, apice obtusissimis, poris minutis," and he adds in the more detailed description that the colour is "flavicans" and the habitat "profundum."

Forsk. his specimens, like those described later by Klunzinger, came from the Red Sea.

The specimen collected by Dr Willey, from which the photograph (Fig. 1) was taken, is 15 centimetres in height and spreads out in one plane to a width of about 18 centimetres. The branches are slightly compressed and in the centre of the mesh reach a thickness of about 7 mm.

The degree of fusion in the branches is very variable. In one place, seen to the left of the centre in the figure, the branches have fused to form a plate 3 centimetres in breadth. In other specimens plates larger than this may be seen.

The surface of the corallum is generally smooth, but near the base of the "live"¹ corallum several irregular protuberances may be seen. These protuberances are due to the irritation caused by the growth of parasitic Algae² and worms.

These Algae are very common on the specimens, attacking not only the basal parts but in some cases the growing points. In one fragment a distinct spherical gall has been formed which can only be attributed to the effort made by the Millepore to surround and overwhelm the Alga which had attacked it. Parasitic cirripedes are rare on the Millepores of this facies, but as one fragment exhibits the characteristic key-hole aperture of *Pyrgoma milleporae* it cannot be said that they are free from the attacks of cirriped parasites.

The cycles of pores are on the whole well marked, but it will be noticed on

¹ This term is used in its conventional sense and refers only to those parts of the corallum which were invested with living tissues when the specimen was killed by the collector. When a Millepore or a portion of a Millepore dies in its position on the reef the surface is attacked by parasites and sedentary creatures of various kinds and is thereby altered so materially that there can never be any doubt that it was dead if it be subsequently examined.

² It is difficult to identify this Alga, but it appears to be closely related to *Laurencia caespitosa* Lamour. vel hybrida. *Annal. Bot.* v.

examining the figure with a lens that wherever there are ridges or other irregularities in the surface the gastropores are so crowded that the cycles become quite indistinct. Forskal says that the pores of this species are "minute." Actual measurements of twenty gastropores situated in the middle parts of the corallum give an average diameter of 0.28 mm. This average is above the average size of the diameters of gastropores in other specimens of *Millepora* (see list of average diameters of gastropores given in my paper in *Proc. Zool. Soc.*), and consequently it would be erroneous to state that in these specimens the pores are "minute."

The base from which the specimens of this facies spring is, in all cases which I have examined, either narrow or small. The base which supports the whole of the corallum shown in Fig. 1 is only 30 mm. by 10 mm. This is a point of some importance because the character of the ground on which the *Millepore* embryo settles must to a considerable extent determine its facies. It is quite certain that an embryo settling on a base only 300 square millimetres in area could never give rise to great plates of corallum similar to the one shown in the photograph Fig. 7. The colour of most of the specimens included in this facies is pale yellow brown.

FACIES *complanata*.

Several specific names have been given to *Millepores* which assume the form of a broad leaf or a series of lamellae more or less coalescent. The descriptions given in the literature of the so-called species and of specimens attributed to species are so bewildering that it has become quite impossible to distinguish what form of growth is to be attributed to *M. complanata* Lamk., *M. plicata* Esp., *M. platyphylla* Ehr., and *M. foliata*, etc.

It will be convenient to consider those *Millepores* which form by coalescence broad lamellae under the name '*complanata*.' These forms are practically those included by Pallas in his variety γ , with the following definition:

"Elegantissima omnium varietas quae effingitur in laminas latas, crassiusculas longitudinalibus plicis undulatis, sublacinosas margine terminali retiusculo. Hae laminae in rupibus passim congestae, plerumque subparallelo positu; interdum tamen situ variantes imo decussantes aliquae reperiuntur."

The photographs given in Figs. 2 and 3 are the two halves of one specimen which shows admirably the manner in which the *Millepores* of this facies are formed.

The specimen began life on a broad frond of dead coral 14 centimetres broad and about one centimetre thick at the margin. (In this case the dead coral which forms the support is a *Millepore* covered by encrusting algae, foraminifera, zoantharian corals, etc.) At first the young *Millepore* spread as a thin crust over the support forming a broad base. At the same time a certain number of broad digitiform processes grew out from the middle of the base, which became broader and began to coalesce. If the process had been continued a little further, the lines of the original processes would have been obscured and a plate similar to that shown in Fig. 4 would have been formed.

The specimen shown in Figs. 2 and 3 is only one of several in Dr Willey's collection which give us information as to the mode of origin of the *Millepore*

colony, but it is the best for showing the intermediate stage between the branching form and the lamellar form which the colonies so frequently assume when growth has proceeded further. I have very carefully compared this specimen with the one shown in Figure 4 and with several specimens of the facies *dichotoma*, young and old. Neither the texture, size of the pores, average number of dactylopores to each gastropore nor any other feature indicates that we have here more than one species. A fragment of the specimen in Figure 2 cannot be distinguished by any characters from a fragment of the same size taken from the specimen shown in Fig. 4 nor from a specimen of the facies *dichotoma* unless it be a slight difference in colour or the number and size of tubercular processes on the surface.

Fig. 5 is a photograph of a specimen which under the old system would have been included in the species *M. nodosa* Esp. which closely resembles in form, as pointed out by Moseley (1.), Milne Edwards's *M. gonagra* vel *M. tuberculosa*.

Moseley thought that a good character of this species is that the pores are distributed over the surface in well-marked systems. I cannot agree with this conclusion because in the two specimens in this collection the degree of definition of the systems varies enormously. An examination of Fig. 5 with a magnifying glass shows that in the lower half of the specimen the systems are very well marked, whereas in the upper half and at the edge the pores seem to be distributed indiscriminately. A better example of the variability of this feature in *Millepora* may be seen in Fig. 3 where the systems are perfectly distinct on the flat surface of the corallum but completely fused on the tubercles and at the edges.

SPECIMEN OF IRREGULAR FACIES.

The large specimen of which a photograph is given in Fig. 7, presents us with so many different forms of growth that if pieces of it were judiciously broken off they might under the old system be placed in at least three different species. The upright flattened plate to the left in the figure with a relatively smooth flat surface would be included in the species *M. complanata*; the tuberculate knob on the right corresponds fairly well with the descriptions of *M. gonagra* v. *tuberculosa* of Milne Edwards; while the central parts might be considered to belong to the species *M. verrucosa*. Two important factors have brought about the irregularity of this specimen.

In the first place the specimen to a certain extent assumed the shape of an irregular lump of coral conglomerate on which it grew. During the transmission of the specimen the crust of live coral on one of the most prominent knobs was broken off and reveals an underlying knob of dead coral. This is shown in the photograph Fig. 6. This protuberance then which would have looked perfectly natural in the unbroken fragment was due not to any intrinsic tendency of growth of the species but to the chance form of the lump on which the individual specimen happened to be growing.

In the second place the irregular warty or tuberculate surface of the corallum is largely due to the influences of parasitic barnacles.

It will be noticed that at the summit of some of the tubercles there is a key-hole aperture, considerably larger in diameter than the gastropores, which is surrounded by one or in some cases two ill-defined circular grooves. These marks indicate the presence of *Pyrgoma milleporae* just below the surface and there can be little doubt that the irritation caused by the growth of the cirripede gave rise to hypertrophy of the coenosarc and produced the tubercle. In many cases however tubercles are present which have no cirripede holes at their summits, but the following considerations prove that the tubercles are nevertheless the results of parasitic irritation. A number of tubercles showing no external signs of the parasite were filed down to a level with the surface of the corallum or deeper, and others were fractured vertically with a bone forceps. In half of these an irregular cavity was found containing the remains of cirripede shells; in the remaining half no such cavity or remains were found.

The apparent absence of the cirripede remains may be due to incomplete examination, i.e. they may have been deeper down than I was able to get by filing from the surface, or the parasite may have been completely destroyed by the parasitic fungus *Achlya*, and the hole subsequently filled up with fresh corallum. The fact that in a large number of cases the tubercles are associated or were associated with parasites suggests that the tuberculate surface cannot be an intrinsic specific character, and this is confirmed by the fact that in the W.-Indian Millepores and in the Millepores from water 5—7 fathoms in depth parasitic cirripedes are rarely found and the surface of these corals is nearly always smooth.

FACIES *verrucosa*.

I have given a figure of the largest and finest specimen in Dr Willey's collection as it forms a fitting termination to the series which has been described. If we were only acquainted with Millepores similar to the one figured in Fig. 8 and the one figured in Fig. 1, it would never have occurred to anyone that *M. verrucosa* and *M. dichotoma* were not good species. Yet the evidence which has been accumulating for the past ten years appears to me to prove that they ought not to be considered even as "varieties" of the one species. I believe that sister larvae might produce forms as widely different as these if they happened to settle on parts of the reef where the conditions of tide, bottom, food, parasites etc. were widely different.

The particular specimen is characterised by a surface covered with numerous tubercles of approximately the same size and shape, the key-hole cirripede aperture may be seen on the summit of many of these tubercles but in the majority of them the cirripede has been overwhelmed. The base of this specimen (not shown in the figure) which was broken across exhibits splendidly the dead cirripede shells corresponding with the tubercles. There is one more feature about this photograph which calls for notice. A broad meshed network of dark lines may be seen covering the corallum, running principally between the tubercles. These lines are marked by the deposit of a yellowish pigment, and I believe they represent the course of the principal and largest canals of the coenosarc such as those figured in Moseley's (1.) Plate XIV. Fig. 4 C, and in my woodcut 1, in *Q. J. M. S.*, Vol. xxxii. The marking out of these canals is not easy to explain. I have only noticed it two or

three times among all the coralla I have examined, so that it is probably very rare. I am inclined to attribute it to the zooxanthellae which being present in large numbers in these canals have, in drying, stained the corallum. In coralla that have been slightly waterworn, I have occasionally seen this canal system marked out in grooves.

THE SPIRIT SPECIMENS.

Dr Willey sent me for examination a considerable number of specimens of different forms of growth carefully preserved in spirit.

I have decalcified large pieces and examined series of sections of specimens of dichotomous and of complanate forms of growth and of five different fragments from different localities. Unfortunately none of them show any signs of sexual organs.

I have found the medusae of *Millepora* in three collections only, namely that of Prof. Haddon from Torres Straits, of Mr Gardiner from Funafuti, and of Mr Duerden from Jamaica. My experience is that when the medusae occur at all they occur in great numbers. It is extremely probable therefore that further investigation of Dr Willey's specimens would not shew these organs.

The examination of the sections however has led to some interesting results in other directions.

In the first place I may say that the anatomy of gastrozooids, dactylozooids and coenosarc, and the size of the large and small nematocysts are the same exactly in the dichotomous forms as in the complanate forms. No specific differences can be drawn between the soft parts of these specimens, nor between the soft parts of these specimens and those from other parts of the world which I have examined. Two points of considerable interest in my sections of Dr Willey's material attracted my attention, namely, the condition of the nematocysts and the presence of a curious parasitic growth which has not hitherto been described.

NEMATOCYSTS. In my earlier investigations on the structure of *Millepora* it appeared to me that Moseley's account of the nematocysts of this genus was complete and accurate, but the discovery of a spiral fibril running up the lumen of the thread of the large nematocysts in some of the sections of Dr Willey's *Millepores* caused me to undertake their investigation with great care. The result is that while confirming the accuracy of Moseley's excellent observations in all essential details, I am able to add one or two points which have not been recorded.

As Agassiz originally pointed out, there are two kinds of nematocysts in *Millepora* which are usually referred to as the large and small nematocysts respectively.

The large nematocysts "never occur in the tentacles of the zooids, being confined to the coenosarc, and being present in greatest abundance in zonal masses around the bases of the zooids lying in the superficial layer of the ectoderm" (Moseley I.)

Regarding the small nematocysts Moseley says they are of a kind "which appears to be confined to Hydrozoa and not to occur at all in Anthozoa, viz. that in which a bladder-like enlargement of the thread occurs at that part of it which is immediately next the mouth of the cell, the bladder being armed near its summit by three spines set in one whorl. The three spines in this form of nematocyst in *Millepora* are remarkably long, and directed at right angles to the axis of the thread, instead of recurved, as is usual. These nematocysts vary very much in size.

The one figured is one of the largest observed, being two-thirds of the length of the ovoid nematocysts. The larger examples of these three-spined nematocysts are of comparatively rare occurrence, only a few being present in some of the tentacles and being more commonly present in the tentacles of the gastrozooids. The smaller nematocysts of this form have not more than one-sixth the length of the large ones."

All of these points I have repeatedly observed. The large nematocysts in the sections of some of Dr Willey's specimens exhibit a condition which we may assume is one of incomplete extension, the vesicle containing a fibril spirally wound at the base, which is continuous with the spiral fibril running in the lumen of the thread (Pl. XVI. Fig. 2). All of these nematocysts are fixed in the ectoderm of the coenosarc.

On examining the surface of the corallum with a lens or in searching through the débris at the bottom of the bottle in which it was present, a certain amount of white fluffy material may be found which consists of a felt-work of fully exploded nematocysts. An examination of these with the microscope shows details similar to those described and figured by Moseley (Pl. XVI. Fig. 1, copied with slight modifications from Moseley), no spiral fibril in the vesicle and thread being visible with ordinary powers of the microscope. Now it must be noticed that in the former the nematocysts are in contact with living cells, and may themselves be considered to be alive. In the latter the nematocysts may have been shot and dead sometime before the specimen was preserved.

It might be assumed that the fibril which is shown in Figure 2, drawn from a nematocyst fixed in the ectoderm, is the terminal portion of the thread fixed in the act of passing along the lumen of the basal portion of the thread to complete the fully exploded nematocyst. Its form indicates however that it is much more plastic than the outer wall of the thread, and as it stains deeply in haematoxylin, which the wall of the thread does not do, it must have at least a slightly different chemical structure. Moreover the spiral axis is equally present in fully exploded threads (see below). The appearance that the fibril has in the thread is strikingly like that of the myophan thread in the stalk of *Vorticella*, as Dr Willey remarks. These notes on the structure of the nematocyst of *Millepora* have some significance when taken in conjunction with the statement made by Dr Willey that the threads are retractile. In a private letter to me he says, "I think there can be no doubt now about the retractility of these threads. I did not observe it once or twice, but repeatedly in different stocks of *Millepora*. The retraction takes place suddenly just like a *Vorticella*." The retraction of these threads was observed with a lens, and it was particularly noticed that they were confined to the coenosarc and had no relation to the dactylopores or gastropores.

These observations of Dr Willey's seemed to me of such importance that I felt it to be essential to examine again with very great care the thread of the fully exploded nematocyst to see if it exhibited any traces of the spiral fibril. For this purpose I collected some of the felt-like substances from the surface of a colony, stained it deeply in Kleinenberg's haematoxylin, and examined teased preparations of it with Zeiss's 2 mm. oil immersion lens.

The result of this observation was to prove that in many of the fully exploded nematocysts a faint spiral line runs through the whole length of the thread. Considering the fact that some of the nematocysts collected in this way may have been shot a long time before they were preserved it is not surprising that some of the threads do not stain at all, but the observed facts are quite consistent with the view that a myophan fibril does run the whole length of the large nematocyst thread in *Millepora*.

I may point out in this place that the figure given by Moseley (II) of the large nematocyst of *Cerianthus bathymetricus* shows a fibril running up the lumen of the thread very similar to that which I have drawn in Fig. 2, but I can find no statement in this paper or in others which I have consulted as to the retraction of the thread.

Schulze, Allman and others have described fine processes proceeding from the base of the cnidoblast towards the deeper parts of the ectoderm, which Claus, Chun and Hamann considered to be probably muscular in function¹.

Thinking that the retractility of the nematocyst observed by Dr Willey might possibly be due to the cnidopod, as Allman calls these processes, drawing back the whole nematocyst, I examined the sections of the best preserved material in my possession again very carefully to see if such processes occur in connection with the cnidoblast in *Millepora* and arrived at the following conclusions. The nematocyst is enclosed in a cnidoblast provided with an oval nucleus. Pseudopodial processes of the protoplasm often occur penetrating between the walls of neighbouring cells. These processes do not differ in structure from other parts of the protoplasm of the cnidoblast and are consequently not specialised myophan strands (Pl. XVI. Fig. 5). The nematocysts may occur either in the ectoderm or in the endoderm, and probably migrate from the deeper parts of the canal system to the surface according to the needs of the colony. There is no cnidocil, and the nematocysts may be exploded before they reach the surface (Pl. XVI. Fig. 4).

Moseley originally pointed out that the large ovoid nematocysts occur in the canal system in positions at a considerable depth from the surface, but apparently thought that they were always in the ectoderm. The thin sections which we can now prepare in great numbers have convinced me that they also occur in the endoderm, and in all probability migrate to the surface when necessary. The fact that in some of my sections a large number of exploded nematocysts are found at a considerable depth from the surface is of importance as proving that nematocysts are not always exploded by the trigger action of a cnidocil. In these cases the explosion must be due to a stimulus brought from a distance by the nervous system and not to a direct irritation of the cnidoblast.

SIZE OF THE NEMATOCYSTS. The vesicle of the large nematocysts is in all cases approximately .02 mm. in length. In every specimen there will be found slight

¹ I have not thought it necessary to discuss more fully these points in the anatomy of the cnidoblasts, as the reader may find a full statement of the views on the subject in Allmann's Challenger Report on the Hydroida II. pp. xiv—xvii, and in the more recent paper of von Lendenfeld, "Die Nesselzellen der Cnidaria." *Biol. Centralbl.* xvii. July 1897.

variations in this measurement, due I believe to the fact that some of them are, when killed, slightly more oval than others, but on taking the average of a large number of measurements the length is found to vary very slightly indeed from .02 mm. The small kind of nematocyst varies much more in size than the large kind. The largest of them which I found in the tentacle of a gastrozoid (Pl. XVI. Fig. 6), was .02 mm. from the whorl of spines to the base of the vesicle. The length of the vesicle before explosion must have been about two-thirds of this measurement.

PARASITE. In two of the spirit specimens, one a foliate form from Sandal bay and the other a plicate form, I noticed numerous white spots scattered over the surface of the coral having the general appearance of a rash. On decalcifying a portion of the specimen these spots were found to be quite irregular in form and varying in size from minute dots to lumps half a millimetre or more in length. It occurred to me that these bodies might be connected with the well-known parasitic fungus *Achlya penetrans*, the mycelial threads of which are almost invariably found in the deeper parts of the skeleton of Millepora. I have not yet detected these threads in the living superficial layer of any Millepore I have examined, but Moseley (I.) says, "They are not confined to the calcareous structure, but in *Millepora nodosa* (from Tahiti) at least occur also in abundance in the soft superficial tissues."

These bodies however are not apparently connected with the mycelial fibres, and their microscopic structure does not suggest that they belong in any way to a filamentous fungus. Each of the white bodies which can be seen on the surface by macroscopic observation is seen in section to be composed of a number of irregular lumps (Pl. XVI. Fig. 7). These lumps are so irregular in form and size that it is extremely probable they are due to shrinkage during preservation and of no morphological importance. Each lump consists of numerous minute lancet-shaped rods .004 mm. in length, arranged with their longer axes parallel. No trace of a membrane or wall enclosing the bodies as a whole or the lumps into which they are broken up can be found, and most of the bodies are completely isolated from their neighbours by normal healthy millepore tissues in which none of the rods can be traced. These rods readily stain in Haematoxylin, Borax-Carmine and Safranin, and when teased out on a cover-slip, separate in rows rather than in strings, as shown in the figure (Pl. XVI. Fig. 8).

The conclusion seems to be then that these bodies are clusters or zoogloae of parasitic bacteria which may provisionally be called *Bacterium milleporae*. I cannot call to mind in the literature of the subject any previous note on the occurrence of bacteria in corals, and I can find nothing similar to these bodies in any of the preparations I have made of millepores and other hydrocorallines from other parts of the world. (Cf. Duncan.)

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EXPLANATION OF PLATES XII.—XVI.

PLATES XII.—XV.

A series of Woodburytype reproductions of photographs of *Millepora alcicornis* taken by Mr J. T. Wadsworth.

FIG. 1. A specimen of the facies '*dichotoma*,' $\frac{1}{2}$ natural size. Some of the pores in this and the following figures show a white central spot like a columella. This is an effect of light and does not represent any actual structure.

FIGS. 2 and 3. Two pieces of a young form of the facies '*complanata*,' $\frac{3}{4}$ natural size. Both of these photographs show the pore systems well-marked and distinct on the general smooth surface but confused at the edges and on the summits of the tubercles. The manner in which the young Millepore encrusts a dead coral is well shown in fig. 2.

FIG. 4. A piece of a large lamella belonging to the facies '*complanata*,' $\frac{1}{2}$ natural size. The surface of this piece is generally smooth, but two rounded prominences marked by the cirripede hole may be seen.

FIG. 5. A specimen belonging to the facies '*complanata*' covering a dead piece of coral, $\frac{2}{3}$ natural size.

FIGS. 6 and 7. A specimen of very irregular facies.

FIG. 6. $\frac{3}{4}$ natural size, taken to show in the middle a knob from which the live coral has been broken off, revealing the dead coral on which it has grown, and which has given it the character of its form.

FIG. 7. $\frac{2}{5}$ natural size, showing the whole specimen. To the left a portion of the whole is of the form of growth described by authors as *M. complanata*, in the middle that described as *M. verrucosa*, and to the right that of *M. nodosa*. The summits of several of the tubercles are marked by cirripede holes.

FIG. 8. A specimen of the facies '*verrucosa*,' $\frac{1}{4}$ natural size.

PLATE XVI.

- FIG. 1. Large nematocyst of *Millepora*, the outline copied from Moseley. In the thread a thin spiral fibril may be seen in many specimens. The mode of attachment of this fibril to the cyst wall is uncertain.
- FIG. 2. Large nematocyst drawn with the assistance of the Camera lucida from a section of one of Dr Willey's millepores, showing a spiral fibril running through the thread distally and proximally coiled in the cyst.
- FIG. 3. A portion of that part of the thread of the large nematocyst which is beset with spirally arranged rows of thorns. In this part of the thread the spiral fibril drawn in Fig. 2 cannot be clearly traced but it appears again in the portion of the thread beyond the thorny part.
- FIG. 4. Drawn from a section of a millepore given to me by Professor Haddon. Shows a large exploded nematocyst deeply seated in the tissues below the Ectoderm. *Ect.* Ectoderm, *End.* Endoderm, *z.* zooxanthella.
- FIG. 5. An unexploded nematocyst in its cnidoblast drawn from a section of the same material as fig. 4. *n.* nucleus of the cnidoblast, *ps.* a pseudopodium of the cnidoblast. Details of the thread coiled up in the cyst are omitted.
- FIG. 6. One of the small kind of Millepore nematocyst. Outline drawn with camera from a section of a gastrozoid tentacle in Dr Willey's material.
- FIG. 7. Outline sketch of canal system as seen in vertical sections showing the manner in which the *Bacterium milleporae* (bact.) occurs in zoogloecae, at the surface and in the canals.
- FIG. 8. The *Bacterium milleporae* as seen by Zeiss's 2 mm. oil imm.



FIG. 1.
MILLEPORA.



FIG. 2.
MILLEPORA.

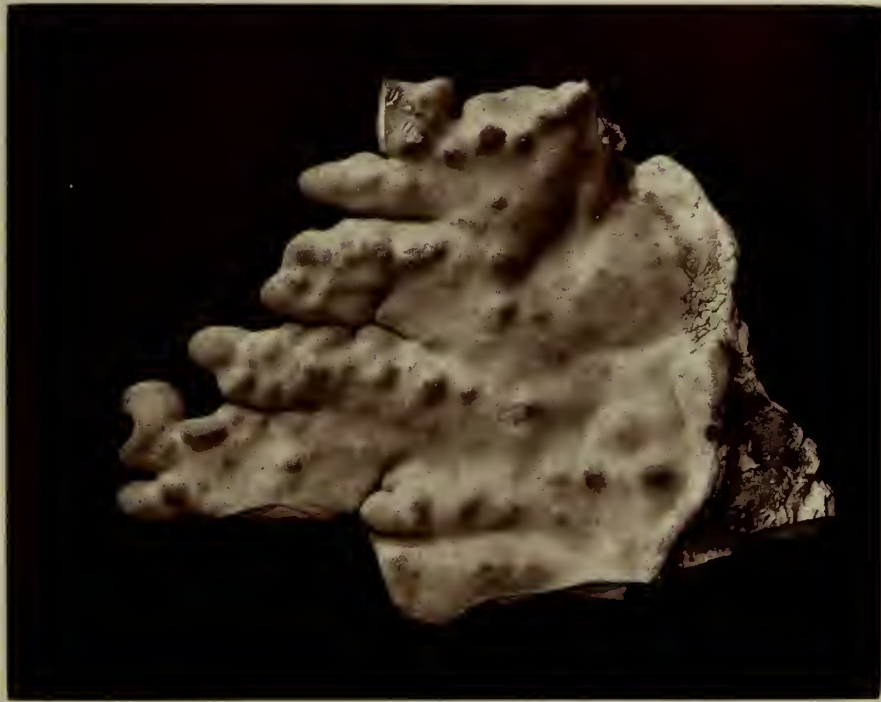


FIG. 3.
MILLEPORA.



FIG. 4.
MILLEPORA.



FIG. 5.
MILLEPORA.



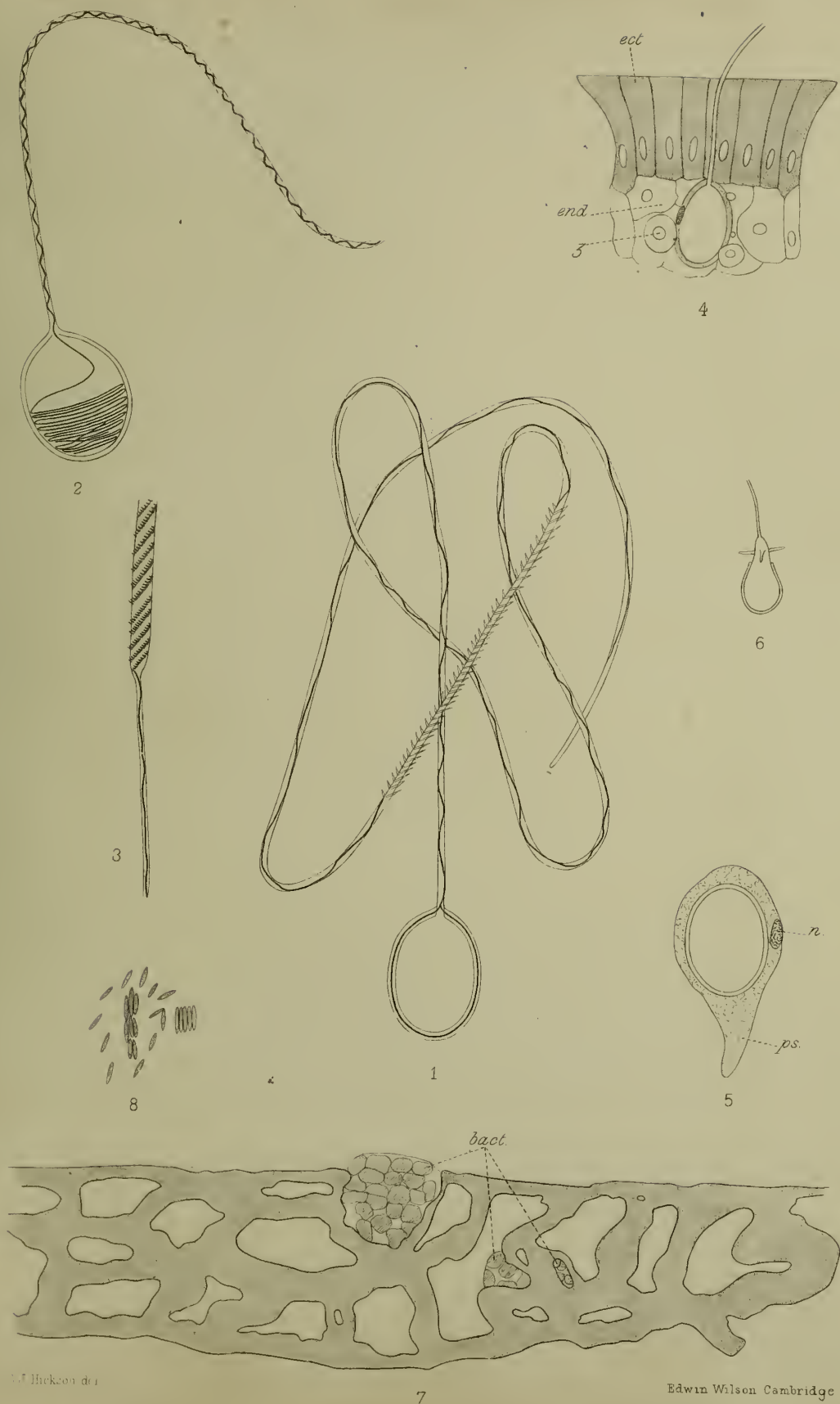
FIG. 6.
MILLEPORA.



FIG. 7.
MILLEPORA.



FIG. 8.
MILLEPORA.



REPORT ON THE ECHINODERMS (OTHER THAN HOLOTHURIANS) COLLECTED BY DR WILLEY.

BY F. JEFFREY BELL, M.A. (OXON.),
Emeritus Professor in King's College, London.

With Figures on Pl. XVII, and One Figure in the text.

Dr Willey's collection of Echinoderms having been made in the intertropical area of what Mr T. Lyman called the "Great Ocean" contains, as was to be expected, a large number of well-known and widely distributed species; but he has, I am glad to say, been successful in finding Prof. Studer's *Astropyga elastica*, though he has not been equally happy as regards *Schleinitzia crenularis*, which I should very much like to see. He has obtained also some very interesting early stages of various Echinoderms, which will be useful when the changes that occur in species receive the attention they deserve. One very remarkable Echinoid will be duly described in its proper systematic place, and a figure is given of a young starfish as to which I am quite unable to offer any suggestions.

CRINOIDEA.

1. *Antedon indica*.

Comatula indica, E. A. Smith, Phil. Trans. vol. 168 (1879), p. 564.

Antedon indica, P. H. Carpenter, Chall. Rep., Comatulæ (1888), p. 225.

Loc. Blanche Bay, New Britain.

The specimens described by Mr Smith came from Rodriguez, so the area of the species is largely increased.

2. *Antedon tuberculata*.

Antedon tuberculata, P. H. Carpenter, Chall. Rep., Comatulæ (1888), p. 232.

Loc. Fiji.

This species does not appear to have been found since the 'Challenger' dredged a single specimen near Kandavu in 1874. Like Carpenter, I can distinguish it from *A. indica*.

3. *Actinometra typica*.

Phanogenia typica, Lovén, Öfv. Vet. Akad. Förhandl. 1866, p. 231.

Actinometra typica, P. H. Carpenter, Notes Leyd. Mus. iii. (1881), p. 195.

Loc. New Britain.

The history of this species has been very fully given by P. H. Carpenter in the work referred to, in the 'Challenger' Reports and elsewhere.

4. *Actinometra grandicalyx*.

Actinometra grandicalyx, P. H. Carpenter, Journ. Linn. Soc. xvi. (1882), p. 520.

Loc. New Britain.

I am by no means certain of the identity of Dr Willey's specimen with this species; it should be pointed out that it was founded by P. H. Carpenter on a single specimen, which is in the Hamburg Museum, but I am unable to make any better suggestion.

5. *Actinometra bennetti*.

Alecto bennettii, Müller, MB. Ak. Berlin, 1841, p. 187.

Actinometra bennettii, Böhlische, Arch. f. Nat. 1866, p. 90; P. H. Carpenter, Notes Leyd. Mus. iii. (1881), p. 212.

Loc. Loyalty Islands.

It is of interest to observe that the two specimens collected by Dr Willey came from the same Islands as the specimen described by Dr Böhlische in 1866.

6. *Actinometra parvicirra*.

Alecto parvicirra, Muller, MB. Akad. Berlin, 1841, p. 185.

Actinometra parvicirra, P. H. Carpenter, Trans. Linn. Soc. (1879), p. 27, and Chall. Rep. Comat. (1888), p. 338.

Loc. Sandal Bay, Lifu.

Dr Herbert Carpenter has dealt so fully with this species, which is widely distributed in the intertropical area, that there is nothing of importance for me to add.

ECHINOIDEA.

7. *Cidaris metularia*.

Cidarites metularia, Lamk., An. s. Vert. iii. (1816), p. 56.

Cidaris metularia, de Bl., Actinol. (1830), p. 232; A. Ag. Rev. Ech. (1872), p. 385.

Loc. Loyalty Islands.

This is another species of very extensive distribution.

8. *Phyllacanthus annulifera*.

Cidarites annulifera, Lamk., An. s. Vert. iii. (1816), p. 57.

Phyllacanthus annulifera, A. Ag., Rev. Ech. (1872), p. 387.

Loc. Milne Bay, New Guinea, 36 fms.; and New Britain.

Though with a somewhat extended area this species is comparatively rare. The spines, when fresh, were seen to be "quite covered with an incrusting Zoanthid."

9. *Phyllacanthus gigantea*.

Chondrocidaris gigantea, A. Ag. Bull. Mus. Comp. Zool. i. (1863), p. 18.

Phyllacanthus gigantea, id. Rev. Ech. (1872), p. 390.

Loc. Lifu.

This is a very rare species, but as it has been found at either end of the inter-tropical area (Sandwich Islands and Mauritius) it may be expected to appear from time to time at intermediate localities.

10. *Phyllacanthus imperialis*.

Cidarites imperialis, Lamk. An. s. Vert. iii. (1816), p. 54.

Phyllacanthus imperialis, Brandt, Prodr. descr. Animal. (1835), p. 68; A. Ag. Rev. Ech. (1872), p. 391.

Loc. Lifu.

This again is not a common species, but is known from a wide area.

11. *Astropyga elastica*.

Astropyga elastica, Studer, MB. Ak. Berl. 1876, p. 464.

Loc. New Britain, 50—70 fms.

The two specimens collected serve to confirm the accuracy of Prof. Studer's observations, but do nothing to increase our knowledge of the extent of the area which the species occupies. Dr Willey tells me that this form is commonly taken in the Nautilus baskets.

12. *Astropyga radiata*.

Cidaris radiata, Leske, Addit. Nat. Disp. Echin. (1778), p. 52.

Astropyga radiata, Gray, Ann. Phil. xxvi. (1825), p. 426.

Loc. Loyalty Islands; so far as I know this is a more westerly locality than has as yet been recorded for this species. One example is quite young, and will be useful in a study of the changes which the test undergoes during growth.

13. *Mespilia globulus*.

Echinus globulus, Linn. Syst. Nat. x. (1758), p. 664.

Mespilia globulus, Ag. and Des. Ann. Sci. Nat. vi. (1846), p. 358; Lovén, Bih. Svenska Vet. Akad. Hdlgr. xiii. (1887), iv. no. 5, p. 66.

Loc. Loyalty Islands.

14. *Temnopleurus*, juv.

Loc. New Britain.

15. *Salmacis*? sp. (pl. xvii. figs. 1 and 1a).

Dr Willey collected, at New Britain, a single specimen of a remarkable and interesting form, which is quite new to me, and has puzzled me a good deal.

The excellent figures which Mr Berjeau has drawn of it leave little for me to add, but I may point out that, though at first sight it appears to be a Cidaroid,

it is certainly a Triplechinid; the long solid spines, banded red and yellow, and the purple sinuous lines that mark out the interambulacra produces an elegant effect, which must be very marked during life.

I can only call attention to the form, and hope for a series of larger specimens. As it is suggested by the editor that it should have a name I propose to call it *S. elegans*.

16. *Echinometra lucunter*.

Echinus lucunter, Linn. Syst. Nat. x. (1758), p. 665.

Echinometra lucunter, Lütken, Videns. Meddel. 1863 (1864), p. 86; Lovén, Bih. Sv. Vet. Akad. Hdlgr. xiii. (1887), iv. no. 5, p. 157.

Loc. Cape Ventenat, Normanby Island, New Guinea.

17. *Heterocentrotus trigonarius*.

Echinus trigonarius, Lamk. An. s. Vert. iii. (1816), p. 51.

Heterocentrotus trigonarius, Brandt, Prodr. descr. Animal. (1835), p. 266; A. Ag. Rev. Ech. (1872), p. 430.

Loc. Loyalty Islands.

18. *Arachnoides placenta*.

Echinus placenta, Linn. Syst. Nat. x. (1758), p. 666.

Arachnoides placenta, Agass. Mon. Scutell. (1841), p. 94; Lovén, Bih. Svensk. Vet. Akad. Hdlgr. xiii. iv. (1884), no. 5, p. 178.

Loc. New Britain.

ASTEROIDEA.

19. *Astropecten monacanthus*.

Astropecten monacanthus, Sladen, Chall. Rep., Aster. (1888), p. 216, *ibique cit.*

Loc. New Britain.

The 'type' of this species was collected by H.M.S. 'Challenger' off the Philippines. It would appear to be rare.

20. *Pentaceros lincki*,

Loc. Blanche Bay.

21. *Pentaceros nodosus*,

Loc. Blanche Bay.

} see Bell, P. Z. S. 1884, p. 72.

} id. t. c. p. 70.

These two species herd together in the narrow strait which divides the island of Matupi from the mainland. According to Dr Willey's observations the two species grade into one another both as regards colour and nodosity. He thinks they are either varieties of one species or else that they cross-breed together and produce hybrids.

22. *Pentaceropsis obtusata*.

Asterias obtusata, Bory de Saint Vincent, Encycl. Méthod. (1827), p. 140, pl. ciii.

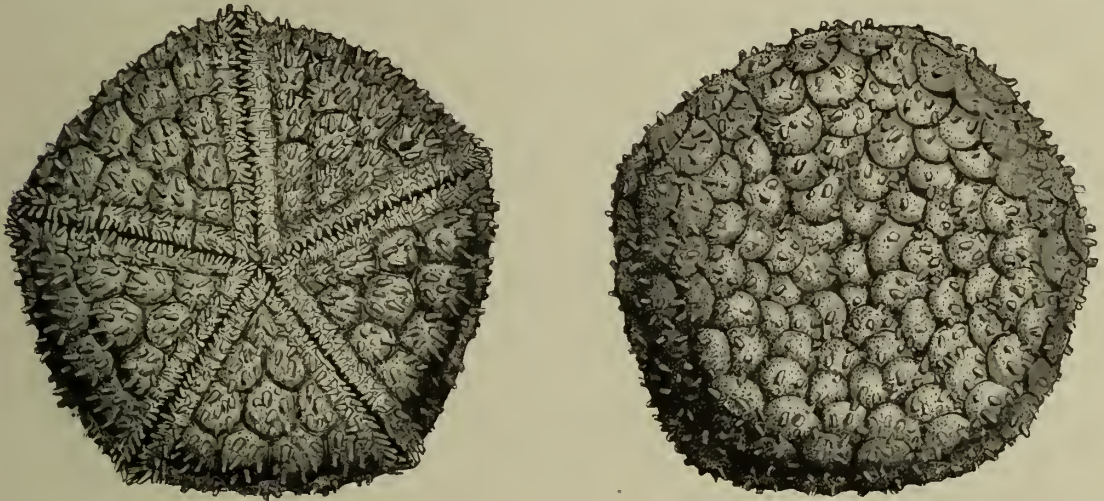
Pentaceropsis obtusata, Sladen, Chall. Rep., Aster. (1889), p. 351.

Loc. Blanche Bay.

Several specimens were obtained of this rare species. Mr Sladen indicates very briefly his reason for forming a new genus for the species, and the series at my disposal is too short to justify my supporting or declining to support his view.

23. *Culcita*.

A small specimen from Sandal Bay is of very great interest, as it is, so far as I know, the only example of its genus in which there is an imbrication of the plates of the dorsal surface (see fig.). The bearing of this on the affinity of *Culcita* to *Asterina* need not be insisted on.



Oral and aboral views of an undetermined specimen of *Culcita* from Sandal Bay, Lifu; showing imbrication of dermal plates on the dorsal surface. Diameter of specimen 13.5 mm.

24. *Gymnasterias carinifera*.

Asterias carinifera, Lamk., Anim. s. Vert. ii. (1816), p. 556.

Gymnasteria spinosa, Gray, Ann. and Mag. vi. (1840), p. 278.

Gymnasterias carinifera, Sladen, Chall. Rep., Aster. (1889), p. 357, *ibique citata*.

Loc. Lifu.

This is a species which appears to extend from the Red Sea to Panama, and is often found in collections from the Pacific.

25. *Asterina exigua*.

Asterias exigua, Lamk., Nat. Hist. s. Vert. ii. (1816), p. 554.

Asterina exigua, Sladen, Chall. Rep., Aster. (1889), p. 392, *ibique citata*.

Loc. Loyalty Islands.

This widely spread species was well represented.

w.

26. *Fromia milleporella*.

Asterias milleporella, Lamk., t. c., p. 564.

Fromia milleporella, Sladen, op. cit., p. 401, *ibique citata*.

Loc. Loyalty Islands.

27. *Linckia multiforis*.

Asterias multiforis, Lamk., t. c., p. 565.

Linckia multiforis, v. Martens, Arch. f. Nat., 1866, p. 65.

A very large number of this common and widely spread species were obtained at Lifu; common as it is, it is always of great interest from the manifold stages of budding that are to be observed, while often it exhibits exquisite galls, the result of the presence of *Stylifers*. It is needless for me to say anything more, where the Drs Sarasin have said so much, and have illustrated it so well (see *Ergebn. naturw. Forsch. Ceylon*, i. (1883), p. 73, pl. ix.).

28. *Nardoa tuberculata*.

Nardoa tuberculata, Gray, Ann. and Mag. vi. (1840), p. 287.

Loc. Sandal Bay; Loyalty Islands; Enganin Group, British New Guinea.

This is another species which was largely represented in the collection. Mr Sladen is in error in thinking he is the doer of 'a simple act of justice' in restoring Gray's name to this species; that was done, thirty years ago, by Prof. Verrill (see *Trans. Connect. Acad. i.* p. 285).

29. *Acanthaster echinites*.

Asterias echinites, Ellis and Solander, Nat. Hist. Zooph. (1786), pls. 60—62.

Acanthaster echinites, Sladen, Chall. Rep., Aster. (1889), p. 537.

Loc. Loyalty Islands.

30. *Mithrodia clavigera*.

Asterias clavigera, Lamk., Hist. nat. An. s. Vert. ii. (1816), p. 562.

Mithrodia clavigera, Sladen, Chall. Rep., Aster. (1889), p. 539.

Loc. Loyalty Islands.

31. *Echinaster purpureus*.

Othilia purpurea, Ann. and Mag. vi. (1840), p. 282.

Echinaster purpureus, De Loriol, Mém. Soc. phys. Genève, xxix., no. 4 (1885), p. 10, *ibique citata*.

Loc. Off China Straits, British New Guinea.

This common species was very abundantly represented.

32. *Echinaster eridanella*.

Echinaster eridanella, M. Tr. Syst. Aster. (1842), p. 24.

As this species is already known from New Caledonia and New Ireland it is right it should be recorded from New Britain.

OPHIUROIDEA.

The few Ophiuroids with two exceptions are common and widely distributed species; the exceptions are *Ophiomastix mixta*, which was collected in the Fijis by H.M.S. Challenger, and *Ophiomusium simplex*, which was first taken at Amboyna.

33. *Ophiolepis annulosa*.

Ophiura annulosa, Lamk., An. s. Vert. ii. (1816), p. 543.

Ophiolepis annulosa, M. Tr. Arch. f. Nat. 1840; Lyman, Chall. Rep., Ophiur. (1882), p. 19, *ibique citata*.

Loc. Blanche Bay, New Britain.

34. *Ophiomusium simplex*.

Ophiomusium simplex, Lyman, Bull. Mus. C. Z. v. (1878), p. 115; id. Chall. Rep., Ophiur. (1882), p. 93.

Loc. New Britain.

35. *Ophiocoma erinaceus*, M. Tr. Syst. Aster. (1842), p. 98.36. *Ophiocoma scolopendrina*, Agass., Mém. Soc. Sci. Neuchatel, i. (1835).

Specimens of these two so-called species from China Straits, British New Guinea, revive the doubts raised by the late Dr Brock as to the advisability of keeping them separate (Zeits. f. wiss. Zool. xlvii. p. 495); it is certain that interbreeding experiments would give very interesting results.

37. *Ophiocoma pica*.

Ophiocoma pica, M. Tr. Syst. Ast. (1842), p. 101.

I do not remember finding this species associated with the two preceding before, but there is no cause for astonishment at the fact.

38. *Ophiomastix annulosa*.

Ophiura annulosa, Lamk., An. s. Vert. ii. (1816), p. 543.

Ophiomastix annulosa, M. Tr. Syst. Ast. (1842), p. 107.

Loc. Loyalty Islands.

39. *Ophiomastix mixta*.

Ophiomastix mixta, Lütken, Vid. Selsk. (5), viii. (1869), p. 99.

Loc. Sandal Bay, Lifu.

DESCRIPTION OF FIGURES ON PLATE XVII¹.

FIGS. 1, 1^a. *Salmacis elegans* from the aboral, and oral poles. $\times 3$.

FIGS. 2, 2^a. Upper and under views ($\times 2$) of a Starfish, whose systematic position I am quite unable to determine, unless, indeed, it be allied to the *Pythonasterinae* of Mr Sladen. The single specimen is quite young, and it is possible that, later on, it would have lost the comparatively long spines that project from its dorsal surface; at this stage, at any rate, there is no sign of any nidamental pouch; the spines on either side of the ambulacral grooves are united by membrane into continuous fringes. This tantalizing specimen was collected at Sandal Bay, and it is to be hoped that larger examples with more definite characters will soon be obtained. It is hopeless to give it a name, as the editor suggests, as it is impossible to say in what genus it should be placed.

¹ Plate XVII faces page 150.

HOLOTHURIANS.

By F. P. BEDFORD, B.A. (CANTAB.).

With Figures on Plate XVII.

OWING to the kindness of Professor F. Jeffrey Bell I had the opportunity of working out the Holothurians in Dr Willey's collection, and I am much indebted to him for advice and assistance, and also for the use of the room which he kindly placed at my disposal at the Natural History Museum.

The collection comprises 24 species of which two, as far as I can discover, have not hitherto been described; of one of these there is unfortunately only one specimen, which is not in a sufficiently satisfactory state to render a complete description possible; of the other there are two specimens, and they seem to belong to a species which helps to bridge over the gap between *Holothuria cinerascens* and *Holothuria moebii*, and which I venture to call *Holothuria willeyi*. I also describe distinct local varieties, or topotypes, of *Synapta ooplax* and *S. reticulata*, both of which were represented by numerous specimens.

I. FAMILY. SYNAPTIDAE.

1. *Synapta ooplax* v. Marenzeller, var. *laevis* nov. var. Fig. 3 *a, b, c*.

Reference: v. Marenzeller. Verh. Zool. bot. Ges. Wien, 1881, p. 4, Taf. iv. fig. 1.

Loc. Sandal Bay, Lifu, Loyalty Islands.

Twenty-six specimens up to 15 cm. long; colour light reddish in spirit. They differ from the description given by v. Marenzeller in a few details; as far as I have observed, the holes of the anchor plates invariably have smooth margins with the exception that very rarely a pair of small teeth may be present, situated opposite to one another; the teeth figured and described by him as surrounding some of the holes do not seem to occur in this variety; biscuit-shaped spicules very common on the ambulacra, these occur only in the longitudinal radial muscles and not in the body-wall.

The Polian vesicles varied in number from 1 to 4 in the specimens dissected (about 6). In all other respects the specimens agree with those of v. Marenzeller.

2. *Synapta beselii* Jaeger.

Synapta agassizii Selenka. E. Selenka, Z. f. w. Z. 17, 1867, p. 361, Taf. xx.

References: C. Semper. Reisen Philipp. Hol. 1868, p. 11, Taf. i.

H. Ludwig. Z. f. w. Z. 35, 1881, p. 577.

H. Théel. Challenger Holothuroidea, 1885, p. 9.

K. Lampert. Die Seewalzen, 1885, p. 223.

Loc. Off China Straits, New Guinea.

Three fragments only, one of which was labelled as "striped" and distinctly answered to the description of var. *agassizii*, the other two were labelled as "spotted" when alive. Length of living specimens 60—64 cm. and upwards.

Lampert regards this form as a separate species; Semper has pointed out the similarity of colouring of *S. beselii* from different localities, and if not a true species the present form must be regarded as a well-marked colour-variety, although Mertens as quoted by Ludwig says of *S. beselii* "Die Farbe variirt wenn sie sich auch meist in denselben Farbentönen bewegt."

3. *Synapta reticulata* Semper, var. *nigro-purpurea* nov. var.

C. Semper. Reisen Philipp. Hol. p. 13, Taf. iv. figs. 4, 5.

References: C. Ph. Sluiter. Natuurk. Tijds. v. Ned. Indie, Bd. 47, 1887, pp. 214—215.

K. Lampert. Zool. Jahrb. Systematik, Bd. iv. 1889, p. 845.

Loc. Isle of Pines, New Caledonia, between tide-marks.

Fourteen specimens up to 13 cm. in length; colour "crimson-black" when alive.

They seem to be similar to Semper's specimens in all respects except colour and size of anchors and anchor-plates, which are 24 mm. and 18 mm. in length respectively.

Lampert describes three examples from the Mermaid Straits which also differ from the type in the absence of reticulate markings, and Sluiter describes a colour variety under the term *var. maculata*, so that the identity need not be doubted on these grounds. It seems possible that the coloration may be correlated with the habitat, since Sluiter found the type at a depth of 6—8 fathoms and *var. maculata* at low-water mark.

4. *Synapta recta* Semper.

C. Semper. Reisen Philipp. Hol. 1868, p. 14, Taf. iv. figs. 2, 3.

Loc. Off China Straits, New Guinea.

One specimen 4 cm. long; tentacles up to 12 mm. in length; colour "speckled" when alive.

Corresponds exactly to Semper's description and figures. In fresh condition, 13 tentacles were counted. The colour consists of alternate light and dark greyish longitudinal bands, thickly speckled with whitish spots.

5. *Synapta vittata* Forskal.

References: J. Müller. Arch. f. anat. u. phys. 1850, pp. 132—134. *S. serpentina*.

F. Held. Vierteljahrsch. d. Nat. Gesell. in Zürich, 1857, pp. 264—

266. *S. vittata* and *S. raynaldi*.

References: C. Semper. Reisen Philipp. Hol. 1868, pp. 11, 12, Taf. iv. figs. 6, 7, 8.
S. grisea and *S. glabra*.

C. Ph. Sluiter. Semon's Forsch. in Austr. u. Mal. Arch. Bd. 5, Lf. 1.
S. serpentina and *S. glabra*.

Loc. Off China Straits, New Guinea.

Only the anterior end of one specimen, the colour of which when alive was mottled yellow and black, giving an irregularly reticulate pattern. Length about 50 cm. Fifteen tentacles with numerous (about 30) pinnae, two black spots at inner base of each tentacle; anchors, anchor-plates, and miliary granules like those of *S. glabra* and *S. grisea* figured by Semper and those of *S. raynaldi* figured by Held; they are 29 mm. and 26 mm. in length respectively. Cartilaginous ring present; calcareous ring with short ascending processes; Polian vesicles numerous; gonads equal, a pair of wide tubes with numerous diverticula. There is some doubt as to how far this species is distinct from *S. serpentina*. The calcareous deposits of the specimen examined resemble what has been described for the latter, but there is said to be no cartilaginous ring in *S. serpentina*.

6. *Chirodota rufescens* Brandt.

Chirodota variabilis Semper. C. Semper. Reisen Philipp. Hol. 1868, pp. 20, 21. Taf. v. figs. 6, 7, 9—11, 19, &c.

Reference: H. Ludwig. Z. f. w. Z. 35, 1881, pp. 578, 579.

Loc. Loyalty Islands.

One specimen 9.7 cm. long, colour uniform reddish in spirit.

Seventeen tentacles; wheels of different sizes, all toothed; curved rods in body-wall confined to ambulacra; shorter rods occur in the radial longitudinal muscles; anatomy agrees with Ludwig's description of Brandt's original example.

Loc. Blanche Bay, New Britain.

Another specimen 6 cm. long $\times$ 1 cm. broad, differs from the preceding in the absence of the red colour, in the transparency of the skin, and in the distribution of the curved rods over the interambulacra as well as the ambulacra; 17 tentacles, the pinnae of which appear to be retractile into a sheath at the base (cf. Mertens).

7. *Chirodota rigida* Semper.

C. Semper. Reisen Philipp. Hol. pp. 18, 19, Taf. iii. fig. 3, Taf. v. figs. 3, 13, &c.

Reference: H. Ludwig. Zool. Jahrb. Systematik, III. 1888, p. 819. *C. amboinensis*.

Loc. Off China Straits, New Guinea.

A number of fragments including only one head; colour reddish-purple in spirit, with the wheel-papillae standing out as conspicuous white tubercles.

Tentacles, calcareous ring, deposits of body-wall, and colour correspond to Semper's description, but the pieces were too fragmentary to determine any further anatomical details; no C-shaped deposits, wheels up to .1 mm. in diameter, rods up to .07 mm. in length.

II. FAMILY. DENDROCHIROTAE.

1. *Pseudocucumis africana* Semper.

H. Ludwig. Zool. Jahrb. Syst. Bd. III. 1888, pp. 815—817.

Cucumaria africana Semper. C. Semper. Reisen Philipp. Hol. 1868, p. 53, Taf. xv. fig. 16 (since corrected by Ludwig).

Cucumaria assimilis Bell. F. J. Bell. Jour. Linn. Soc. XXI. 1886, p. 27, Pl. II. fig. 4.

Pseudocucumis thœli Ludwig. H. Ludwig. Sitz. Ak. d. Wiss. Berlin, 1887, Hft. ii. p. 1236. Taf. xv. figs. 12—16.

Reference: R. Koehler. Rev. Suisse de Zool. III. 1895, p. 277.

Loc. Isle of Pines, New Caledonia.

Three specimens 2.6 cm., 3.2 cm. and 4.5 cm. in length, of a uniform dark slate-colour.

A short historical account of this species is given by Prof. Koehler (l.c.). The tentacles were retracted in all three specimens collected so that their number and arrangement could not be made out. In all other respects the specimens agree with Ludwig's description of *P. thœli*, except that the "Kalkstäbchen" are confined to the feet themselves as in Semper's original example re-examined by Ludwig, l. c. 1888; the retractor muscles are inserted a short distance in front of the middle of the body as in Ludwig's specimens in which the tentacles were expanded, so that this condition does not seem to depend so much upon the state of retraction of the tentacles as upon individual variation.

2. *Orcula* (? *Phyllophorus*) *dubia* n. sp. Pl. XVII. Fig. 4.

References: H. Ludwig. Arb. aus d. zool. zoot. Inst. in Würzb. II. 1875, p. 95.

Orcula tenera.

H. Ludwig. Zool. Jahrb. Systematik, III. 1888, pp. 812—814. Taf. xxx. fig. 20. *Orcula tenera* and *Phyllophorus brocki*.

R. Koehler. Rev. Suisse de Zool. III. 1895, p. 278, fig. 2. *Phyllophorus bedoti*.

Loc. Lifu, Loyalty Islands.

One specimen, 10.5 cm. long; the description of this specimen is necessarily very incomplete. Owing to the complete contraction of the tentacles their arrangement could not be deciphered, but they appeared to number 15.

The only deposits that I can find outside the end-plates of the tube-feet are (1) "Hirseplättchen"¹ like those described by Ludwig in *Phyllophorus brocki* and seen in a number of other Holothurians, and (2) occasional needle-shaped spicules of various sizes pointed at each end and often somewhat curved; both kinds are infrequent, the "Hirseplättchen" occurring loosely aggregated together. The calcareous ring has posterior bifurcate projections made up of a number of pieces on both radialia and interradialia, although only those attached to the former separate to form a definite arch as in *Phyllophorus bedoti* Koehler, and *Orcula tenera* Ludwig.

One Polian vesicle and one small stone-canal attached to the mesentery; gonads well developed, arranged like the fringe on a towel on each side of the mesentery.

¹ These are minute crenulated nodules like a millet-seed.

III. FAMILY. ASPIDOCHIROTAE.

1. *Holothuria impatiens* Forsk.*H. botellus* Selenka.

E. Selenka. Z. f. w. Z. 17, 1867, p. 335, Taf. xix. figs. 82—84.

C. Semper. Reisen Philipp. Hol. 1868, p. 82.

Loc. Lifu, Loyalty Islands.

Five specimens quite typical from 2 cm. to 6.4 cm. in length, tables .09 mm. diameter. In the smallest specimen the ventral feet are arranged quite distinctly in rows, buttons average about .09 mm. in length and are quite separate from the dorsal papillae.

2. *Holothuria pardalis* Sel. var. *insignis* Ludwig.*H. insignis* Ludwig*H. lineata* Ludwig*H. peregrina* Ludwig

H. Ludwig. Arb. a. d. Zool. Zoot. Inst. in Würz. Bd. 2,
1875, pp. 103, 105, 106, figs. 28, 30, 42.

? *H. inhabilis* Selenka. E. Selenka. Z. f. w. Z. 17, 1867, p. 333, Taf. xix. figs. 73—74.

References: C. Ph. Sluiter. Natuurk. Tijds. v. Ned. Ind. 47, 1887, p. 192.

H. Ludwig. Sitzb. k. Ak. d. Wiss. Berlin, 1887, p. 1226.

Loc. Reef off New Caledonia.

One specimen 3.6 cm. long; light grey in colour with violet-brown spots (cf. Sluiter); corresponds fairly to *H. insignis* Ludw., most of the buttons are somewhat arched, the central rib being often in a plane different from and parallel to that containing the sides and their surface is often uneven so that they approach the condition seen in *H. inhabilis* Sel. The resemblance of the button-like spicules of *H. pardalis* var. *insignis* to those of *H. lentiginosa* von Marenzeller (Résultats des camp. scient. accomp. par Albert 1^{er} Prince de Monaco. Fasc. vi. 1893) may be noted. The latter may possibly turn out to be a variety of *H. pardalis*.

3. *Holothuria vagabunda* Selenka. (Pl. XVII., Fig. 5 a, b, c.)

E. Selenka, tom. cit. p. 334, Taf. xix., figs. 75—76.

References: v. K. Lampert. Die Seewalzen, 1885, pp. 71, 242.

H. Théel. Challenger, Hol. 1885, pp. 180, 218.

R. Koehler. Mém. de la Soc. Zool. de France. T. VIII. 1895, p. 383.

Loc. Lifu, Loyalty Islands.

Two small specimens, 4.1 cm. and 2.2 cm. in length, belong to this species; the deposits agree with those described by Théel; discs of tables vary from .1 mm. to .04 mm. in diameter and spire varies in length considerably; the tables with small disc are provided as a rule with a short thick spire, while in the larger tables the spire is narrower and longer and very rarely more than one transverse bar can be seen; the crown nearly always carries 8 teeth and some of the small discs are uneven or even spinous on the margin; the deposits seem to approach those normally found in *H. remollescens* Lampert (fig. 5 a, b); the buttons, fig. 5 c, are occasionally

somewhat irregular. One large Polian vesicle. One fixed stone-canal. Cuvierian organs large and whitish in spirit. One of the specimens contained a *Eulima* (?) in buccal cavity.

Two more specimens from Lifu, Loyalty Islands, 10.5 cm. and 5.1 cm. in length, must also probably be referred to this species. The deposits differ in the fact that the tables do not vary much in size, the disc may be smooth, uneven or spinous, and the crown bears 10—12 teeth which are generally irregular. One of these specimens contained one very large Polian vesicle, one free stone-canal and Cuvierian organs; the other specimen had a *Eulima* attached to external surface, and was left unopened.

4. *Holothuria decorata* v. Marenzeller.

v. Marenzeller. Verh. Zool. bot. Ges. Wien, 1881, pp. 19, 21.

References: H. Ludwig. Notes from Leyden Museum, iv. 1882, p. 135.

H. Ludwig, xxii. Ber. d. oberh. Gesell. f. Nat. Giessen, 1883, p. 166.

K. Lampert. Zool. Jahrb. Syst. iv. 1889, p. 810.

Loc. Loyalty Islands.

One specimen, 13 mm. long, seems to agree fairly well with the original description; in colour it distinctly recalls *H. monacaria* from the same locality, a fact which lends support to Ludwig's hypothesis that *H. decorata* is the young of *H. monacaria*; the body-wall is thick (v. Ludwig, 1883, l.c.). Tables like those described, except that the disc is generally provided with at least 10 peripheral holes and often carries short spines; the longer spires may have as many as 5 transverse bars.

Buttons often uneven or arched (cf. *H. minax* Théel and *H. inhabilis* Sel.) and occasionally they have a finely granulated appearance (cf. *H. ludwigi* Lamp.); the distinction made by Ludwig between "Gitterplättchen" and "Schnallen" seems to be an arbitrary one, the one merging quite gradually into the other.

One Polian vesicle, one stone-canal, for greater part free, and terminating in an ovoid madreporite.

5. *Holothuria monacaria* Lesson.

References: K. Lampert. Die Seewalzen, 1885, p. 72.

H. Théel. Challenger, Hol. 1885, p. 172.

Loc. Lifu, Loyalty Islands.

Three specimens 4.5 cm., 10 cm. and 12 cm., in length.

In the smallest specimen a few of the discs of the tables bear short spines. The only specimen dissected had one Polian vesicle, one stone-canal free for about one-third of its length; in the two larger specimens the anterior end of the body is much thinner and more transparent than the rest (method of killing?).

6. *Holothuria maculata* Brandt.

Holothuria arenicola Semper. C. Semper. Reisen Philipp. Hol. 1868, p. 81.

References: H. Ludwig. Z. f. w. Z. 35, 1881, p. 595.

E. Hérourard. Arch. de Zool. Exp. Vol. I., 1893, p. 133, Pl. vii. B.

Loc. Several specimens from Lifu, Loyalty Islands, and one off China Straits, New Guinea.

Most quite typical, but in one of the Lifu specimens the spots are completely absent, and in the New Guinea specimen the spots are much darker and often confluent.

In three specimens dissected, several Polian vesicles and one stone-canal; deposits typical.

7. *Holothuria atra* Jaeg. var. *amboinensis* Semper.

H. Ludwig. Ber. Oberh. Gesell. 22, 1883, p. 170.

Holothuria amboinensis Semp. C. Semper. Reisen Philipp. Hol. 1868, p. 92.

Holothuria atra Selenka.

E. Selenka. Z. f. w. Z. 17, 1867, p. 327. Taf. XVIII. figs. 52, 53.

References: C. P. Sluiter. Natuurk. Tijds. v. Ned. Ind., 1887, p. 187.

K. Lampert. Zool. Jahrb. Syst. iv. 1889, p. 813.

C. P. Sluiter. Semon's Forsch. in Austr. u. Mal. Arch. Bd. 5, Lf. 1, 1894, p. 103.

Loc. Loyalty Islands.

Three specimens, 10 cm., 4.3 cm. and 3.7 cm. in length, all of the *uniform* black or dark-brown colour characteristic of var. *amboinensis*.

Deposits typical, discs of tables not always spinous.

TABLE OF VARIATIONS.

	No. of free stone-canals (in a group)	No. of Polian vesicles	Cuvierian organs
No. 1	8	1	?
No. 2	numerous	2	absent
No. 3	numerous	2	absent

Body-wall very much thicker in smaller specimen than in other two.

8. *Holothuria edulis* Lesson.

Holothuria fuscocinerea Selenka (not Jaeger).

E. Selenka. Z. f. w. Z. 17, 1867, p. 337, Taf. XIX. fig. 36.

Reference: C. Semper. Reisen Philipp. Hol. 1868, p. 89.

Loc. Lifu.

One specimen 10 cm. long; colour in spirit dirty brown, darker on dorsal side.

Size of tables much more reduced than in *H. atra*.

Several Polian vesicles, about 14 stone-canals in a group, no Cuvierian organs.

9. *Holothuria cinerascens* Brandt.

Holothuria pulchella Selenka. E. Selenka. Z. f. w. Z. 17, 1867, p. 329, Taf. XVIII. figs. 61, 62.

References: C. Semper. Reisen Philipp. Hol. 1868, p. 89.

K. Lampert. Die Seewalzen, 1885, p. 82.

H. Ludwig. Z. f. w. Z. 35, 1881, p. 597.

Loc. New Caledonia.

Several specimens from 8 cm. up to 13·5 cm. in length.

The majority have a black ground colour on which the chestnut-coloured papillae and tube-feet stand out, each surrounded by a lighter space; in one specimen the brown colour is replaced by grey. Deposits quite typical.

TABLE OF VARIATIONS.

	No. of Polian vesicles	No. of stone-canals free	Cuvierian organs
No. 1	4	2	small
No. 2	1	3	none
No. 3	8	2	moderately developed

10. *Holothuria willeyi* n. sp. Pl. XVII., Fig. 6 *a*, *b*, *c*.

Reference: v. H. Ludwig. 22 Ber. d. Oberh. Gesell. f. Nat. Giessen, 1883, p. 171. *H. moebii*, and also references to *H. cinerascens*.

Loc. Blanche Bay, New Britain.

Two specimens 2·2 cm. and 1·7 cm. in length in spirit; tentacles retracted; number?; colour in spirit light grey-brown with darker mottlings; tube-feet in 3 distinct rows on ventral surface; papillae(?) on dorsal surface much smaller and scattered; feet and papillae dark; deposits consist of tables and rods, besides the end-discs of the ventral feet. Tables are very infrequent; disc as in *H. cinerascens*, but spire reduced ending frequently in 3 or 4 points as in *H. pervicax*; the rods are of two kinds:—

(1) curved granulated rods exactly like those of *H. cinerascens* up to 125 mm. long;

(2) smooth rods unbranched up to 1 mm. long as in *H. moebii*. No H-shaped deposits.

Calcareous ring as figured (the top of the figure being posterior). One Polian vesicle; 6 stone-canals in a group; no Cuvierian organs.

The two specimens seem to agree in all respects and the species is undoubtedly allied to *Holothuria cinerascens* and *Holothuria moebii*; judging from the observations of Prof. Mitsukuri on *Stichopus japonicus* (Ann. Zool. Jap. Vol. 1, 1897) we might

regard *H. willeyi* as the possible young of *H. moebii*, from which it differs in the presence of tables and absence of H-shaped deposits, but it would be rash without further evidence to assume that the tables migrate during growth to the tube-feet and there become converted into the H-shaped supporting structures mentioned by Ludwig, just as the tables in *Stichopus japonicus* have been shown by Mitsukuri to become converted into the perforated plates of *Holothuria armata*, the two forms being merely different stages in the life history of a single species.

11. *Holothuria difficilis* Semper? C. Semper. Reisen Philipp. Hol. p. 92.

References: H. Ludwig. 22 Ber. d. Oberh. Gesell. Giessen, 1883, p. 173.

H. Théel. Challenger, Holothuroidea, 1885, pp. 219, 220.

H. Ludwig. Zool. Jahrb. Syst. III. 1888, p. 807.

Loc. Loyalty Islands.

One specimen 4 cm. long, colour whitish with dark violet blotches; I was at first inclined to refer this specimen to *Actinopyga parvula*; but I could not make certain of the existence of anal teeth; and the discs of the tables are better developed than in that form, the number of peripheral holes averaging about 25 in number and placed in 2 or 3 concentric circles; buttons generally with 8 holes, sometimes more, rarely fewer. 3 Polian vesicles, 1 small free stone-canal, Cuvierian organs large.

Seems to be more closely related to *A. parvula* than to *H. vagabunda*.

12. *Actinopyga mauritiana* Quoy and Gaimard.

Mülleria mauritiana. v. Selenka. Z. f. w. Z. 18, 1868, p. 116.

Mülleria varians Selenka. E. Selenka. Z. f. w. Z. 17, 1867, p. 310.

Taf. XVII. figs. 4—9.

Reference: K. Lampert. Zool. Jahrb. Syst. IV. 1889, p. 813.

Loc. Lifu, Loyalty Islands.

Several specimens from 3.5 cm. to 11 cm. in length; no distinct arrangement of ventral feet in rows although they are more closely situated in some places than in others; the colour seems to be very variable, the dorsal side is generally darker than the ventral, and there are nearly always indications of lighter spots surrounding the dorsal papillae.

The tentacles were in all cases retracted; in one specimen (the only one in which they were counted) they numbered 26. Deposits &c. quite typical.

13. *Actinopyga lecanora* Jaeger.

References: v. Semper. Reisen Philipp. Hol. 1868, pp. 75, 76, Taf. xxx. fig. 7.

Ludwig. Z. f. w. Z. 35, 1881, pp. 592, 593.

Ludwig. Sitz. Ak. d. Wiss. Berlin, 1887. Hft. ii. p. 1223.

Loc. Loyalty Islands.

Two specimens, 20 cm. and 4.5 cm. in length. In the smaller specimen the ventral feet are in 3 quite distinct rows, the interambulacra being quite devoid of them, anal area lighter than rest of surface but not so conspicuously so as in the larger specimen.

14. *Actinopyga maculata* Brandt.

Mülleria nobilis Selenka. E. Selenka. Z. f. w. Z. 17, 1867, p. 313, Taf. xvii. figs. 13—15.

Reference: H. Ludwig. Z. f. w. Z. 35, 1881, p. 593.

Loc. Lifu.

One specimen 13 cm. long, calcareous ring not markedly conical, possibly referable to *A. hadra* Selenka.

15. *Stichopus chloronotus* Brandt. v. E. Selenka. Z. f. w. Z. 17, 1867, p. 315. Taf. xvii. figs. 20—24. Taf. xviii. fig. 25.

References: H. Ludwig. Sitzb. k. Ak. d. Wiss. Berlin, No. 54 (1887), p. 1224. Taf. xv. fig. 4.

C. Ph. Sluiter. Natuurk. Tijds. v. Ned. Ind. (1887), Bd. 47, p. 195.

K. Lampert. Zool. Jahrb. Syst. Bd. iv. 1889, p. 815.

Loc. Lifu, Loyalty Islands.

Two specimens, 5.6 cm. and 8.1 cm. in length.

The larger specimen contained a *Fierasfer* 8.2 cm. long, which Mr Boulenger has kindly identified for me as *F. homei* Richards. Rosette-shaped bodies as well as intermediate forms between these and the much more abundant C-shaped deposits occurred as figured by Ludwig; S-shaped deposits excessively rare.

EXPLANATION OF FIGURES ON PLATE XVII.

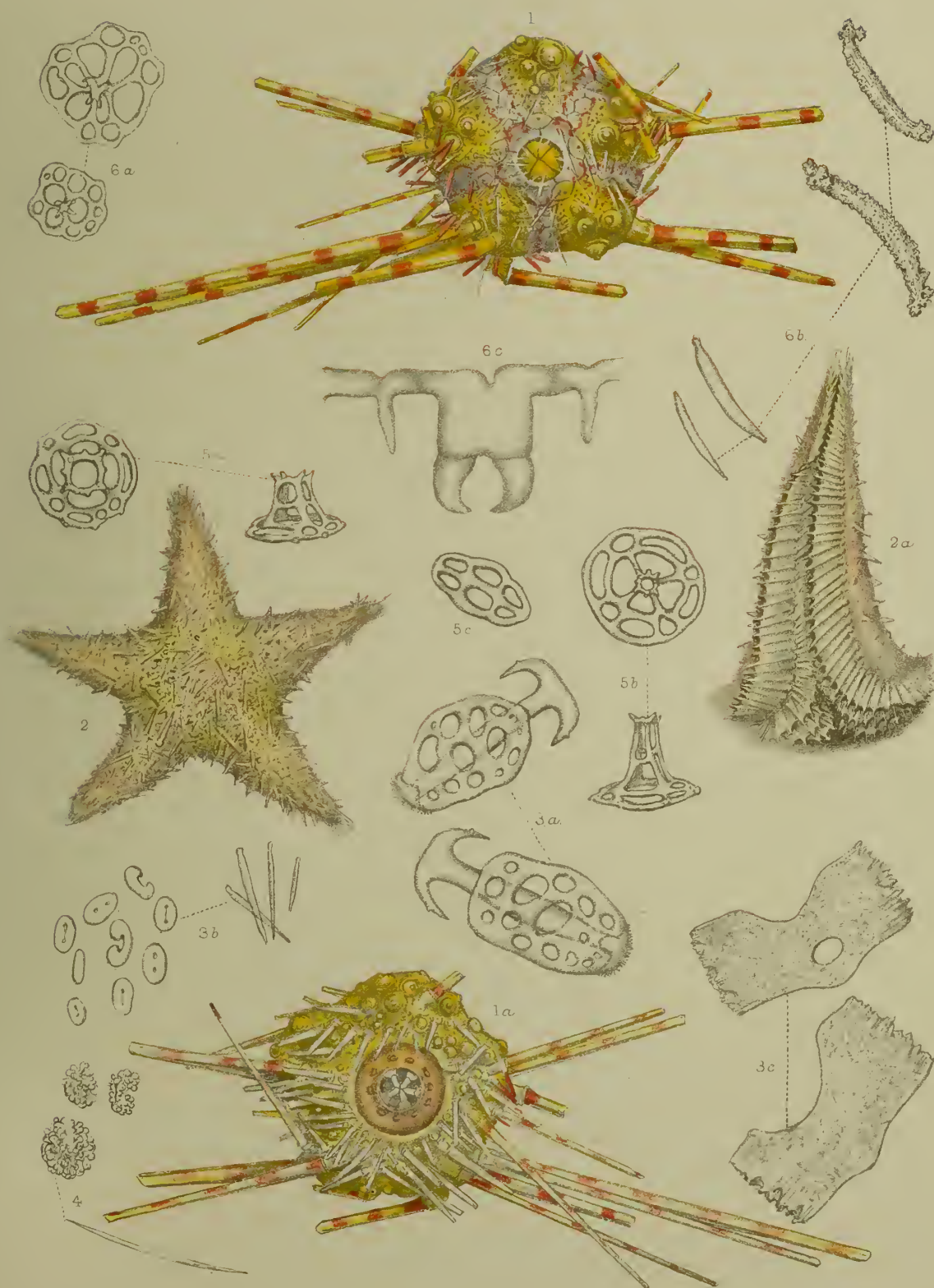
FIG. 3. *Synapta ooplax*.

a. anchor and anchor-plates. $\times 250$.

b. biscuit-shaped ambulacral and rod-like interambulacral spicules. $\times 250$.

c. radial and interradial pieces of calcareous ring. $\times 35$.

FIG. 4. *Orcula* (?*Phyllophorus*) *dubia*, n. sp. Spicules of body-wall. $\times 250$.FIG. 5. *Holothuria vagabunda*, young. *a.* smaller tables, *b.* larger tables, *c.* buttons. $\times 250$.FIG. 6. *Holothuria willeyi*, n. sp. *a.* tables. $\times 250$. *b.* rods. $\times 250$. *c.* calcareous ring (post. end at top of figure). $\times$ about 10.



C. Berjeau del.

West, Newman chromo

A REPORT ON THE SIPUNCULOIDEA, COLLECTED BY
DR WILLEY AT THE LOYALTY ISLANDS AND NEW BRITAIN.

BY

ARTHUR E. SHIPLEY, M.A.,

*Fellow and Tutor of Christ's College, Cambridge, and University Lecturer on the
Morphology of the Invertebrata.*

With Plate XVIII.

Dr WILLEY brought back with him from the Loyalty Islands and New Britain, twenty-three species of Sipunculoidea which are divided amongst the following genera: Aspidosiphon, Cloeosiphon, Phascolion, Phascolosoma, Physcosoma and Sipunculus. Six of his species were found by Mr J. Stanley Gardiner (X)¹ at Funafuti and at Rotuma, Mr Gardiner's collection contained seven species unrepresented in that of Dr Willey.

I have added brief notes on some of the more important features of the species catalogued and a list of the localities from which each has been recorded. An examination of the latter seems to extend the view that I expressed in 1891 (XI) as to the headquarters of the genus Phymosoma (now called Physcosoma) (IX). A further examination seems to show that not only are the headquarters of the last named genus in the Malay Archipelago, but that the seas which surround that group of islands and which stretch up the east coast of Asia as far as Japan and round the north and east of the great Australian continent, and throughout the South Pacific abound in species of Aspidosiphon, Cloeosiphon, Physcosoma and Sipunculus.

Several of Dr Willey's species occur elsewhere, some of them spread through the Indian Ocean and have been collected in the Red Sea and off Mauritius and the east coast of Africa, and several species are cosmopolitan. The genus Cloeosiphon is confined to the seas mentioned above, both it and Physcosoma, and possibly Aspidosiphon are usually found associated with coral-reefs, and this fact probably explains the paucity of their numbers in the eastern waters of both the Pacific and Atlantic Oceans. *Physcosoma agassizii* is however found along the West coast of both Americas from Esquimault to Puntarenas² and again at the Loyalty Islands.

¹ The Roman numerals in brackets refer to the literature at the end of the article. For some of the references I am indebted to Selenka's Monograph (viii.).

² The place here referred to is on the Straits of Magellan. It is not sufficiently recognized that there are three places with this name on the Pacific Coast, besides one in Venezuela. A fact which once took an unfortunate Spaniard many thousands of miles out of his direct route.

The two largest collections of Sipunculoidea, that of Professor Semper, and that of Dr Sluiter, which have been worked out, were collected in the seas surrounding the Malay Archipelago and the Philippine Islands. This probably accounts for the fact that in Dr Willey's collections I have found no new species, and it must also be taken into account in assigning the headquarters of certain genera to these seas. But making due allowance for the fact that these seas have been more carefully searched than many other parts of the globe, it still seems to me that this region is the centre of the above-mentioned genera of Sipunculoidea.

Sipunculus priapuloides has a curious distribution, being found off the Norwegian coast, and again at the Loyalty Islands.

The determination of the species of a Sipunculid is not always an easy matter. Some are readily enough identified and the task is rendered easier if the animal dies with its head extended. But this is seldom the case and then it is not easy to make out the arrangement of the tentacular crown, the number of tentacles etc.

In those species which are provided with hooks the number of rings in which they are usually arranged and the shape of the hooks are of systematic value, but here again we are met with the difficulty that the hooks are often worn away with age and it is not possible to tell how many rings have disappeared. Further, the shape and size of the hooks are by no means constant, but vary considerably in the same species and even in the same specimen.

Again the number of longitudinal muscles in those species in which this muscular coat is split up into bundles is an important specific character, yet in many species the bundles anastomose to such an extent, that the number of bundles at any one level differs from that at any other. This fusing and splitting of the bundles also obscures the question of the exact origin of the retractor muscles.

Perhaps one of the most fruitful sources of difficulty is the difference of colour and the relative prominence of the papillae which is brought about by the varying states of contraction in which the animals die. The pigment of the skin is as a rule aggregated around the mouths of the papillae, and when the animal is killed in a contracted state, the colour is much deeper and the papillae far more prominent than when the skin is relaxed. Hence as in the case of *Cloeosiphon aspergillum* for example, specimens are met with whose appearance is so different that at first sight one is disposed to think that at least two distinct species exist, but a more minute observation tends to show that the superficial differences depend largely on the condition in which the creature died.

Species are a matter of opinion and few groups of animals afford so wide a range for divergency of opinion as do the Sipunculoidea.

It should be mentioned that all the specimens examined had been long in spirit and were killed with diverse reagents. This may to some extent account for the very different appearance and colour presented by some specimens of the same species.

I. GENUS. ASPIDOSIPHON, Grube.

1. *Aspidosiphon elegans* Cham. and Eysenh. (I.)

Three specimens from Lifu, Loyalty Islands. This species was taken by Mr J. Stanley Gardiner at Funafuti, and is described in Selenka's Monograph (II) from the Pacific Ocean, the Philippines, and Koseir.

2. *Aspidosiphon klunzingeri* Sel. and Bülow. (VIII.)

One specimen, measuring 3 cms. from the posterior shield to the base of the introvert. The latter measured in a partially retracted condition 1.5 cm. The breadth of the body is 1 cm.

This species was described by Selenka and von Bülow from three specimens collected by Klunzinger at Koseir. I have described another specimen collected by Mr J. Stanley Gardiner at Funafuti, and as I know of no specimen being figured, I have added a sketch. (Fig. 1.) The species is also recorded by Dr W. Fischer¹ from Amboyna in the Moluccas.

3. *Aspidosiphon rarus* Sluiter. (XII.)

Several specimens of the interesting species were found at Sandal Bay, Lifu. As Sluiter gives no illustrations of the external appearance of this animal, I have added a couple of figures. I append a few notes which amplify the account we owe to the Dutch naturalist. The continuous sheet of longitudinal muscles breaks up anteriorly into a number of anastomosing bundles. Along the ventral middle line on each side of the nerve-cord the muscles of the skin were, in the specimen opened, very thin so that an attenuated transparent strip of integument marked the neural surface. (Fig. 2.) A similar strip was visible externally in some of the other specimens, but not in all. The nephridia were long and each was attached by a posterior muscle to the body-wall.

The most interesting feature in the species is the presence of numerous dark brown spines on the base of the proboscis, arranged in irregular rows. (Fig. 3.) Sluiter has figured one of these, they are not hooks but horny spines, and disappear at the level where the rows of hooks make their appearance.

4. *Aspidosiphon steenstrupii* Diesing. (II.)

Several specimens from Sandal Bay, Lifu, Loyalty Islands, some with their introverts fully expanded and their tentacles spread out. All the specimens were young and showed hardly any trace of calcification in the anterior shield.

A peculiarity of this species is that the cuticle very readily separates from the underlying skin, and often projects from the posterior end of the body for a length at least equal to that of the trunk. The cuticle is transparent and bears on it the outlines of the papillae and their pores.

¹ Semon's Zoologische Forschungsreisen in Australien und den Malayischen Archipel, Bd. v., Lief. III, 1896, p. 338.

This species is also described from the Mauritius and the Philippines, and a specimen of what I take to be the same species was brought home by Professor Weldon from the Bahamas.

5. *Aspidosiphon truncatus* Keferstein. (III.)

Two specimens found in Sandal Bay, Loyalty Islands. This species is recorded from the Mauritius and from Panama.

II. GENUS. CLOEOSIPHON, Quatrefages.

6. *Cloeosiphon aspergillum* Quatrefages. (VII.)

Numerous specimens, some imperfect, from Sandal Bay, Lifu, Loyalty Islands. This species is registered in Selenka's Monograph from Caminguin, Uhoy; Zamboango; Luzon; Mauritius; Ibo and the Viti Islands, and by Dr W. Fischer¹ from Thursday Island, Samoa, and off the East African coast.

An examination of the specimens brought home by Dr Willey affords a good example of the difficulties of systematic work amongst the Sipunculids. His specimens fall readily into two groups, one with a thin transparent skin, of a uniform gray colour, with no apparent papillae, the other of individuals with thick opaque skins, harsh to the touch and with papillae just visible to good eyesight. The members of this latter group are not always uniform in colour and are for the most part either deep yellow or brown. Here I thought are two distinct species. On opening the bodies of one of each group, although the relative size of the organs varied owing to the different states of contraction in which they had been when killed, I could detect no real differences of structure corresponding with the differences of the external appearance. I re-examined the skin with the aid of a lens and found that though few in number there were some papillae in the transparent specimens, chiefly at the posterior end but also round the base of the chalky ring. Finally I prepared specimens of the hooks on the introverts of members from each group; in colour, size and shape, the hooks exactly resembled one another. There thus seemed no doubt that these two groups although they differed externally to a very marked degree formed in reality but one species.

III. GENUS. PHASCOLION, (Théel) Selenka and de Man.

7. *Phascolion manceps* Sel. and de Man. (VIII.)

One specimen only was found, and this was so small that I had considerable difficulty in making out the anatomical features. However, I have little doubt that this specimen belongs to the species *Phascolion manceps* which Selenka and de Man described from a single specimen taken in a Nassa shell in the Philippines (Uhoy). Dr Willey's example was living in the shell of a young Mollusc named *Astralium moniliferum* Hed. and Wil., which has been recently described². The shell and its contents was taken in the trawl off Man Island, Talili Bay, New Britain, in 35 fathoms.

¹ Loc. cit. p. 338.

² P. Linn. Soc. N. S. Wales, Part 1., p. 107.

IV. GENUS. PHASCOLOSOMA, (F. S. Leuckart) Selenka and de Man.

8. *Phascolosoma pellucidum* Keferstein. (IV.)

One specimen found at Lifu, Loyalty Islands. This species has a very wide distribution, being recorded in Selenka's Monograph from the West Indies, Rio de Janeiro, the Philippines, Singapore, and Torres Straits.

V. GENUS. PHYSCOSOMA, Selenka.

9. *Physcosoma agassizii* Keferstein. (III.)

Four specimens from Lifu, Loyalty Islands. Keferstein¹ in a description of this species dwells on the variability of the external features and appearance of this animal, and figures three very different looking specimens of the species. The figure of the Panama specimen closely resembles two of the four individuals collected by Dr Willey, the other two from the Loyalty Islands had their introvert more retracted and more closely resembled another specimen figured by Keferstein who does not mention its place of origin.

The species has been found at numerous places along the western coast of America from Esquimaux to Puntarenas. Fischer records it from Ambrizetta near the mouth of the Congo, and from Ponapé one of the Carolines.

10. *Physcosoma asser* Sel. and de Man. (VIII.)

Numerous specimens from Sandal Bay, Lifu, Loyalty Bay, and one specimen from New Britain.

This is one of the few species of *Physcosoma* which has no hooks, but the skittle shaped papillae on the short proboscis are capped by a thickened cuticular layer which only wants bending over on one side to form a hook.

In Selenka's Monograph it is described from Batjan, Sluiter found it at Billiton, and Fischer records it from Mozambique.

11. *Physcosoma duplicigranulatum* Sluiter. (XIII.)

Four specimens from Blanche Bay, New Britain.

The specimens corresponded fairly well with the species described by Sluiter from the Malay Archipelago except as regards the number of rows of teeth; but in this point they differed very materially *inter se*.

12. *Physcosoma lacteum* Sluiter (XIII.)

Two specimens from Lifu, Loyalty Islands. The species was founded by Sluiter on specimens collected in the Malay Archipelago. The specimens at my disposal agree with his description, but the remarkably wrinkled and parchment-like nature of the skin is not mentioned by him.

¹ Zeitschr. wiss. Zool., Bd. xvii., 1867, p. 44.

13. *Physcosoma pacificum* Keferstein. (III.)

Numerous specimens from Uvea, Loyalty Islands, and a single specimen—rather a small one—from Blanche Bay, New Britain.

The introvert was in every case retracted, and in this condition the length of the body reached a maximum of some 11 cm. Many specimens were however shorter. The species is widely distributed throughout the Indian and South Pacific Oceans.

14. *Physcosoma scolops* Sel. and de Man. (VIII.)

A few specimens from Sandal Bay, Lifu, Loyalty Islands.

The specimens were all small and apparently young forms. In the one I opened there was a curious abnormality in the nephridia. One was small and almost without pigment, but the other was large, dark brown and forked, the two branches being equal in size.

This species has been recorded from Koseir in the Red Sea, Singapore, the Philippines, and Amboyna in the Moluccas.

Fischer regards this species as a variety of *Physcosoma granulatum*, and if this is so, the species occurs on the East and West coasts of Africa, and in the Mediterranean and Adriatic Seas.

15. *Physcosoma spengeli* Sluiter. (XIII.)

Several specimens from Lifu, Loyalty Islands.

Sluiter gives the relative lengths of the diameters of the body, but does not mention the absolute length. Dr Willey's specimens varied much in size, the smaller being some 7—8 mm. long, the larger when fully stretched out, but not with the introvert everted, some 2.5 cms. All the specimens were somewhat bent, i.e., new moon shaped.

VI. GENUS. SIPUNCULUS, Linnaeus.

16. *Sipunculus australis* Keferstein. (IV.)

Eight specimens from Lifu, Loyalty Islands.

Dr Willey's specimens measured from 5 cm. to 18 cm. or so, and were all of a dark almost purplish colour.

S. australis is described in the books as the only species of *Sipunculus* which bears hooks on the introvert. A closer examination of the cuticular structures of the introvert shows that they differ materially from the hooks of *Physcosoma*. Like them however they are cuticular, arranged in circles and bear a definite relation to the glandular bodies of the introvert. This relation is shown in the Figure 4. A transverse section (Fig. 5) shows that the relation of these cuticular structures to the underlying epidermis is similar to that of the *Physcosoma* hooks, but if isolated by boiling in caustic potash it is immediately apparent that their shape is different. Dr Johnson gives as the primary definition of a hook "Anything bent so as to catch hold": if

this definition still holds, the structures are not hooks. They are rather of the shape of a roll of paper so folded as to form a half cylinder rather rounded at both ends. Their presence serves to distinguish this species from others of the same genus, but they should no longer be termed "hooks."

This species is recorded in Selenka's Monograph, from Sydney, the Philippines, Fiji and Amboyna.

17. *Sipunculus billitonensis* Sluiter. (XIII.)

Numerous specimens from Lifu, Loyalty Islands.

Dr Willey's specimens were somewhat shorter than those described by Sluiter, none of them surpassed 18—20 cms. in length, but in other respects they correspond well with the description given of the type. As Sluiter has not figured the outside, I have done so (Fig. 6). The anus is very prominent, ridged and ribbed (Fig. 7).

18. *Sipunculus cumanensis* Keferstein. (III.)

Three specimens varying in length from 3.5 cm. to 12 cm. from Uvea, Loyalty Islands.

I am inclined to think that these specimens belong to the variety *S. cumanensis opacus* Sel. and Bülow, which is recorded from Mauritius and Ascension. The species is widely spread and has been found off Venezuela, and Ascension, in the Red Sea, off Mozambique and the Philippines.

The characteristic transverse dissepiments which stretch across the body on the inside of the skin were, in the specimen I opened, much more prominent in the posterior third of the body than in the anterior two-thirds. The numerous diverticula of the heart are very definitely arranged in two lateral rows.

Some specimens of the variety *S. cumanensis vitreus* Sel. and Bülow were gathered at Blanche Bay, New Britain, and one example at the Isle du Phare, Nouméa. The circular muscles of these specimens were very violently contracted, and gave the outline of some examples a very extraordinary appearance (Fig. 8). One of this variety attained a length of 20 cm.

19. *Sipunculus edulis* Lamarck. (VI.)

Numerous specimens from Lifu, Loyalty Islands, and five from Gavutu near Florida, one of the Solomon Islands.

None of the specimens were, in the retracted state, longer than 12 cms., and were thus shorter than Sluiter's specimens from Reede Batavia, Tandjong Priok which measured 15 to 18 cms. (XII and XIII). But the Lifu specimens may have been young or the Malay specimens may have been extended.

The colour of the examples from Lifu was darker than Sluiter mentions and the circular muscles are divided into fine bundles, but in other respects the animals corresponded with his description. Dr Willey tells me that he thinks the specimens have darkened in spirit, and this is undoubtedly the case in some specimens of *Balanoglossus*—though not in all—that he brought home. The five examples from the Solomon

Islands retained their light straw colour, and the circular muscles do not show any sign of division into bundles, nevertheless I think the two sets of specimens belong to the same species.

This is the species eaten by the Chinese.

20. *Sipunculus mundanus* Sel. and Bülow. (VIII.)

Four specimens from Pigeon Island, New Britain.

The single specimen dredged on the Sow and Pigs Bank, in the British Museum, from which Selenka and Bülow established the species was 33—34 cms. long. Dr Willey's specimens were much shorter, the longest alone attaining a length of 10 cm. As the only specimen opened showed no trace of reproductive organs, it is probable that they are all young forms.

21. *Sipunculus nudus* L.

Two specimens from Blanche Bay. The posterior end of one of them had been seized by a small bivalve which had been partly dragged into the cavity formed by the introversion of this part of the body. This species is practically cosmopolitan, Selenka records it from the North Sea, English Channel, Mediterranean, Zamboango, Malacca, the West Indies and Florida.

22. *Sipunculus priapuloides*, Kor. and Dan. (V.)

One specimen from Lifu, Loyalty Islands.

This specimen agreed very well with the description of the species given by Koren and Danielssen, the portion of the body from which the specific name is taken is however not so prominent as in the figure of the animal given by the Norwegian artists. There is however a clear change in the external appearance of the skin at the posterior end. The specimen which had been two years in spirit was of an iridescent gray colour. Koren and Danielssen's specimens came from Korsfjord near Bergen and from Søndfjord, so that this species has a remarkable range.

23. *Sipunculus vastus* Sel. and Bülow. (VIII.)

Four specimens from Pigeon Island, New Britain; numerous specimens from Lifu, Loyalty Islands, and two from the Isle of Pines, New Caledonia.

This species was found by Mr Stanley Gardiner at both Rotuma and Funafuti and seem common. Selenka records it from the Marshall group of Islands. The Lifu examples were much darker in colour and more opaque than those from New Britain and from New Caledonia; in fact like the most nearly allied of its fellow species, *S. cumanensis*, it may be divided into at least two varieties, *S. vastus albus* which is a pearly white and fairly translucent and *S. vastus obscurus* which is a dark purplish brown and quite opaque.

LIST OF LITERATURE.

The abbreviations here adopted are those suggested by Dr D. Sharp in the Zoological Record.

- I. CHAMISSE AND EYSENHARDT. De animalibus quibusdam e classe vermium lineana, etc. *Acta Ac. Germ.*, T. x. Pt 2, 1821, p. 351.
- II. DIESING. Revision der Rhyngodeen. *SB. Ges. Wien*, Cl. 37, 1859, p. 767.
- III. KEFERSTEIN. Untersuchungen über einiger amerikanische Sipunculiden. *Nachr. Ges. Göttingen*, Juni 13, 1866, and *Zeitschr. wiss. Zool.*, Bd. xvii., 1866, p. 50.
- IV. KEFERSTEIN. Beiträge zur anatomischen und systematischen Kenntniss der Sipunculiden. *Nachr. Ges. Göttingen*, März, 1865, p. 204, and *Zeitschr. wiss. Zool.*, Bd. xv., 1865, p. 433.
- V. KOREN AND DANIELSEN. Fauna Littoralis Norwegicae, Hft. iii., 1877, p. 126.
- VI. LAMARCK. Animaux sans vertèbres. 1st Ed., Bd. iii., 1816, p. 79; 2nd Ed., Bd. iii., 1840, p. 469.
- VII. QUATREFAGES. Histoire naturelle des Annelés. T. ii., 1865, p. 605.
- VIII. SELENKA. Die Sipunculiden. *Reisen in Archipel der Philippinen*, Th. ii., Bd. iv., Abth. i., 1883.
- IX. SELENKA. Die Sipunculiden-Gattung Phymosoma. *Zool. Anz.*, Bd. xx., 1897, p. 440.
- X. SHIPLEY. A Report on the Gephyrea collected by Mr J. Stanley Gardiner at Rotuma and Funafuti. *P. Zool. Soc. London*, 1898, p. 468.
- XI. SHIPLEY. On a new species of Phymosoma, etc. *Quart. J. Micr. Sci.*, Vol. xxxii., 1891, p. 111.
- XII. SLUITER. Beiträge zu der Kenntniss Gephyreen aus dem Malayischen Archipel. *Natuurk. Tijdschr. Nederl. Ind.*, Bd. xli., 1881, p. 495.
- XIII. SLUITER. *Natuurk. Tijdschr. Nederl. Ind.*, Bd. xlv.

DESCRIPTION OF PLATE XVIII.

Figure 1. *Aspidosiphon klunzingeri*, Sel. & Bülow, $\times 2$. The introvert is partially everted.

Figure 2. *Aspidosiphon rarus*, Sluiter, $\times 4$. The introvert is completely extended and shows the spines near the base and the rows of hooks near the head.

Figure 3. One of the spines of *A. rarus* from the base of the introvert, highly magnified.

Figure 4. A view of a piece of the introvert of *Sipunculus australis*, Kef., showing the so-called "hooks," and their relation to the rows of glandular papillae. Much magnified.

Figure 5. A transverse section through three of the cuticular structures called "hooks" of *S. australis* showing the cuticular caps overlaying the special elevations of the skin.

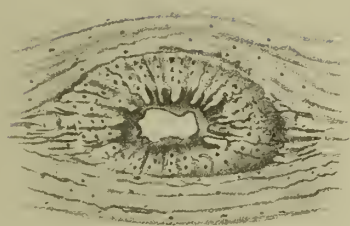
Figure 6. *Sipunculus billitonensis*, Sluiter, $\times 1$.

Figure 7. A much magnified view of the anus of *S. billitonensis*.

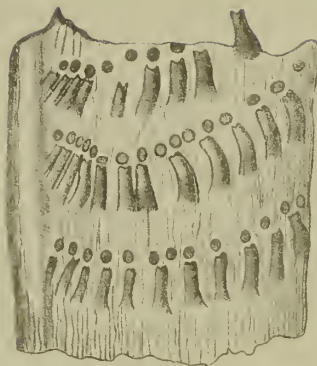
Figure 8. *Sipunculus cumanensis*, Kef., $\times 1$. This specimen shows the violent contractions of the circular muscles which often give specimens of this species a characteristic appearance.



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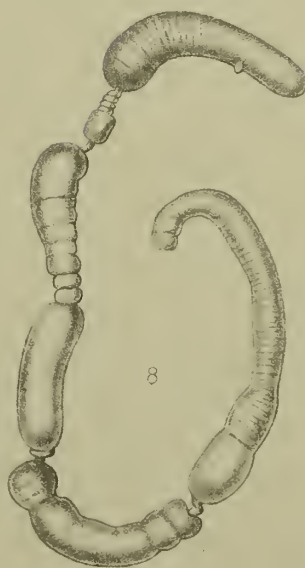
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8

ON THE SOLITARY CORALS, COLLECTED BY DR A. WILLEY.

BY J. STANLEY GARDINER, M.A.,
Fellow of Gonville and Caius College, Cambridge.

With Plates XIX. and XX.¹

THE solitary corals, classified and in part described in this communication, are remarkable for the large number of new species. Dr Willey, however, was the first to undertake systematic dredging in the seas of the South-West Pacific. Probably some may ultimately be found to be young forms, but I do not think any of the new species can possibly be stages of growth (or instars) of previously described forms.

The collection in the British Museum, with which the specimens were compared in August, 1897, and subsequently, includes the Challenger specimens and a large number presented by Count de Pourtalès from the West Indies. A comparison with the Porcupine collection would have been of the greatest possible value, but unfortunately these specimens were, I am informed, sold in America. I must here express my great indebtedness to Prof. F. Jeffrey Bell for his very kind assistance and valuable advice.

FAMILY. TURBINOLIDAE, Milne-Edwards and Haime.

GENUS. *Desmophyllum*, Ehrenberg.

1. *Desmophyllum tenuescens*, n. sp. (Fig. 1.)

The corallum is inversely conical and light with a smooth, very finely granulated stalk, which may be slightly enlarged at the attached base. The costae are very small and do not extend for more than 1.5 mm. down the outside of the corallum.

The calice² is circular or slightly elongate and deep. The septa are thin, very finely granulated on the sides and with entire edges. They are arranged in six systems with three complete cycles. The primaries are 1.1—1.4 mm. exsert and

¹ For explanation of Plates XIX. and XX. see p. 176, *et seq.*

² The term *calice* was first used by Duncan ("Revision of the Families and Genera of the Madreporaria," Jour. Linn. Soc., xviii. p. 200), for the upper opening of the corallite or corallum. The *corallite* is an individual member of a colony and the *corallum* an entire solitary or compound coral.

almost meet in the centre of the calice, nearly obliterating the axial fossa; their upper edges extend nearly horizontally inwards, while their inner edges slope almost perpendicularly down to the axial fossa. The secondaries do not project so far as the primaries, but are thicker and more exsert than the tertiaries, which are very thin and inconspicuous.

Extreme height of the largest specimen, 10 mm. Diameter of the calice of same 5.5 mm. Depth of the calice from the top of the theca to the edges of the septa in the axial fossa 1.5—2 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Seven specimens.

In spirit specimens of this coral the body-wall can be seen to extend for a short distance down the outside of the theca. As the costae do not generally extend below the body-wall, there would seem to be an epitheca deposited by it completely obliterating them and filling up their intercostal spaces. In one specimen, which has been much overgrown by a sponge, the edge of such an epitheca is distinctly visible, the body-wall having evidently been forced to withdraw itself higher up the corallite.

In the two youngest specimens, which are about 5 mm. in height, the shape of the calice is nearly hexagonal. The three cycles of septa are fully developed, but all are very slightly and equally exsert.

GENUS. *Rhizotrochus*, Milne-Edwards and Haime.

2. *Rhizotrochus levidensis*, n. sp. (Fig. 2.)

The corallum is conical and covered by a well developed stout concentrically marked epitheca. There is usually one large radicle with two or three smaller, hollow roots, arising as if from its sides. There are no costae, or costal prominences of the epitheca.

The calice is slightly oval and deep; the wall is formed entirely of the epitheca, no visible theca being present. The septa are not at all exsert, of moderate thickness and entire; their sides are covered with coarse pointed spines. Three distinct cycles in six systems are present. The primaries are much the most conspicuous and meet at the bottom of the very deep, slightly elongated central axial fossa. Slightly below the edge of the epitheca the primaries and secondaries project for some distance nearly horizontally into the calice, ending almost perpendicularly by the axial fossa. Of the primaries two, situated at opposite ends of the axial fossa, are distinctly smaller and slope more gradually inwards than the four at its sides. The tertiaries are very small and narrow, not being more than half as broad as the secondaries.

Extreme height of the largest specimen, 12 mm. Long diameter of the calice of same, 6 mm.; short diameter, 4.6 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Three specimens.

The two smaller specimens have the calice rather more circular than the largest, whose dimensions are given above. The species is evidently very closely allied to *Rhizotrochus affinis* (Duncan), but separated by its smaller size, more circular form and the presence of only three cycles of septa.

GENUS. *Thecocyathus*, Milne-Edwards and Haime.3. *Thecocyathus minor*, n. sp. (Fig. 3.)

The corallum is cylindrical, straight, of nearly equal diameter throughout, closely covered up to the calicular margin by a dense, glabrous epitheca, which is somewhat transversely marked.

The calice is nearly circular in shape and shallow. The septa are closely arranged with extremely granular sides; they project into the calice for about a quarter of its diameter and are scarcely at all exsert. The arrangement of the septa is hard to distinguish, but each of the six systems has at least six septa, the primaries, secondaries and tertiaries being complete, but the quaternaries only represented by two septa on opposite sides of one of the tertiaries. The primaries are a little thicker and project rather further into the calice than the other cycles which are nearly equal. The centre of the calice is filled up by a large number of very granular, round or elongated papilliform projections which gradually decrease towards the centre; these are the pali and the papillae of the columella. The pali appear to be single in front of the primary and secondary septa, but in front of the latter are generally rather larger, higher and more elongated. Pali also are found opposite the tertiary septa, where quaternaries are present, and usually consist of two or three projecting papillae, which merge into those of the columella.

Height of the single specimen, 7 mm. Diameter of the calice of same, 4 mm.

Loc. Sandal Bay, Lifu; 40 fathoms.

This coral is closely allied to *Thecocyathus cylindraceus* (Pourtales) from the Florida Reef. It differs, however, in the very irregular arrangement of its pali and its narrow septa.

GENUS. *Deltocyathus*, Milne-Edwards and Haime.4. *Deltocyathus ornatus*, n. sp. (Fig. 25.)

The corallum is flattened discoidal and free. The inferior surface is almost flat with a slight flattened prominence in the centre almost like the scar of a former attachment. The costae are nearly equally developed; they commence as lines of low, round, blunt granules at the sides of the central prominence, which itself is irregularly covered with similar granules. Towards the margin the costae form a series of rounded ridges and the granulations become sharper and more spiny.

The calice is round, shallow but yet with a large and distinct axial fossa. The septa are very similar in appearance and of nearly equal thickness; their faces are sparsely covered with fine elongated pointed spines. There are six systems and four complete cycles, of which the primaries and secondaries are almost precisely similar, being equally broad, about 1 mm. exsert, and possessing similar elongate paliform lobes. The primaries, however, run rather deeper into the calice and their paliform lobes are rather nearer its centre, higher and more elongated. The tertiaries are not quite so broad as the preceding cycles but extend about as far into the calice as

the secondaries; the exsert portions are about 2·5 mm. in length and pointed, the costae continuing evenly into them but the septa more abruptly broadening where those of other cycles commence; their paliform lobes are more elongated than those of the preceding cycles. The quaternaries are about as exsert as the first two cycles, but do not extend into the calice nearly so far as the other cycles, and fuse with the tertiaries at about the commencement of their paliform lobes. The first three cycles of septa unite with the columella which is large, rather spongy and porous, with an even surface covered by low, small, blunt, subequal papillae.

Extreme diameter of the single specimen, 13·5 mm. Greatest thickness of same 3·4 mm.

Loc. Sandal Bay, Lifu; 40 fathoms.

I do not know any characters by which the primary septa can be satisfactorily differentiated. Six septa are generally broader, rather thicker and more exsert than the rest, and to these the term primary is commonly applied. In the development of *Astroides calycularis* von Koch¹ has shown that twelve septa are laid down simultaneously, and the study of the structure of the hard and soft parts together has in a variety of genera shown that at least the largest twelve septa are entocoelic. In *Fungia*, Bourne² has pointed out that the first twelve septa to appear run straight to the columella in the adult and are not joined at their sides by other septa. Hence I have here termed those septa (twelve in number), which are the broadest, run deepest into the calice and are not joined by other septa, the primaries and secondaries. Six of these septa are undoubtedly in a large number of genera of *Madreporaria* larger and more distinct, so that I prefer to apply the term primary to them.

In *Deltocyathus italicus*, as shown in Pourtales' plates³, the broadest and most exsert septa run singly to the columella. These are the primaries, and the quaternaries can clearly be seen to fuse with the tertiaries. In *Deltocyathus magnificus* (Moseley⁴) the quaternaries fuse with the quaternaries and the latter again with the tertiaries, while the secondaries do not extend quite so far into the calice as the primaries.

GENUS. *Paracyathus*, Milne-Edwards and Haime.

5. *Paracyathus lifuensis*, n. sp. (Fig. 5.)

The corallum is low and almost straight, spreading out to form a large, flat, irregular base of attachment. It is also slightly enlarged above forming a somewhat oval calice. The outside of the corallum is marked by subequal, broad ridges with narrow furrows between extending down to the base; these are covered with low granules—often two rows on each ridge—and represent the costae, corresponding in number to the septa.

The septa are large with roughly granular sides and crowded, almost obliterating the interseptal spaces. They form six systems and four complete cycles with a few

¹ Mitth. Zool. Stat. Neapel, III. p. 284 (1882).

² Trans. Roy. Dublin Soc., Vol. v. p. 205 (1893).

³ Cat. Mus. Comp. Zool., Harvard, No. IV. Pl. II. figs. 1 and 5 (1871).

⁴ Deep Sea Madreporaria, Challenger Reports, p. 148, Pl. XIII. fig. 1.

of the septa of the fifth cycle. The primaries are the largest and everywhere rise about 1 mm. above the tertiaries and quaternaries, which are about 1 mm. exsert and subequal, while the secondaries are intermediate in their characters. The pali are well developed and elongated in the plane of their septa. Usually they are single before the primaries and secondaries, but rather more elongated before the latter, while before the tertiaries they are often bi- or tri-lobed. The columella is depressed about 1 mm. below the pali; it is oval in shape, about 2.5 by 1.4 mm., and consists of a number of small, rounded, granular papillae.

Extreme height of the largest specimen, 10 mm. Long diameter of the calice of same, 9 mm.; short diameter, 7 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Two specimens.

The two specimens of this species were obtained evidently from the same haul of the dredge, and are almost of the same size. Both are much overgrown at the base by algae, sponges and foraminifera. The epitheca is exceedingly thin and difficult to distinguish. It, however, seems to keep pace with the growth of the incrusting organisms, being deposited closely over the theca and costae as the body-wall is withdrawn.

To the same species I also refer a small specimen 4 mm. high by 2.2 mm. in diameter across the calice. The septa are very similar to those of the type, but quaternaries are absent and the quaternaries are only represented by two or three septa. The primaries and secondaries alone have pali, which are single lobed and rather more elongated in front of the secondaries. The columella is represented by a single median papilla.

6. *Paracyathus parvulus*, n. sp. (Fig. 4.)

The corallum tends to be somewhat elongated and is more or less of equal diameter throughout. The outside is marked by very distinct, broad, subequal, granular, ridge-like costae with narrow, deep furrows between. The epitheca is very thin, but closely deposited round the costae and extending up to 3—5 mm. below the calice.

The calice is oval with a deep axial fossa. The septa are broad, granular, slightly exsert and much crowded with small interseptal spaces. Four cycles in six systems are present, of which three are complete, but the fourth is not represented in any of the systems by more than two septa on opposite sides of one of the tertiaries. The primaries are about 0.75 mm. exsert and project for about 1 mm. into the calice. The septa of each cycle are slightly more exsert and broader than those of the cycle next below them, but where quaternaries are developed the tertiaries are enlarged and approximate in size to the secondaries. Rounded pali are present before the primary, secondary and some of the tertiary septa, where quaternaries are present; before the secondaries they are distinctly larger than before the primaries and in front of the tertiaries are sometimes bilobed. The columella is situated rather deeper and ends above with 8—12 very small rounded papillae.

Height of the largest specimen, 16 mm. Long diameter of the calice of same, 4.5 mm.; short diameter, 3 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Eleven specimens.

This species is extremely variable in its mode of growth, some of the specimens being very short but with their calices almost as large as that of the largest specimen the dimensions of which are given above. In the smaller specimens the calice tends to be more rounded but all its general characters, as given above, are clearly marked. Some of the specimens are attached together, as if growing from a stolon, but there does not seem to be any continuity between them, and the corallites so attached are of approximately the same size.

FAMILY. ASTRAEIDAE, Dana.

GENUS. *Lithophyllia*, Milne-Edwards and Haime.

7. *Lithophyllia vitiensis* (Brüggemann).

Scolymia vitiensis, Brüggemann, Ann. Mag. Nat. Hist., Ser. 4, xx. p. 304 (1877).

I have referred one specimen about 1·3 cm. in extreme height by 3 cm. in greatest diameter to this species. The corallum is very irregular in shape, the base having evidently been much worn away by boring organisms, etc. The calice is shallow and considerably filled up by endotheca. The cycles of septa are in parts of the calice rather more distinct from one another than in the type, and the septal teeth are less obtuse.

Loc. Sandal Bay, Lifu; shallow water.

8. *Lithophyllia palata*, n. sp. (Fig. 6)

The corallum is short and very thin with no distinct epitheca. The costae are not pronouncedly marked, but extend down as far as the body-wall and are armed with a number of small, closely set, bluntly pointed teeth.

The septa are very densely granulated at their sides and extend to the columella. There are three complete cycles and six systems; the fourth cycle is nearly complete, and in some of the systems a few spines represent septa of a fifth cycle. The primaries are very thick and distinct, extending inwards at first horizontally with very ragged and broken spiny edges without any large teeth; they then slope steeply with smooth edges towards the columella, before which they generally end each with a large blunt tooth or paliform lobe, rising vertically upwards for 2—2·5 mm. The secondaries are similar in appearance, but towards the columella are very thin with a few pointed teeth and no paliform lobes. The tertiaries and quaternaries are much thinner with numerous subequal pointed teeth. The columella is small and rather open, being formed by the fusion of a large number of small crimped trabeculae from the septal edges.

Diameter of the calice 1·7—2 cm.

Loc. Sandal Bay, Lifu; shallow water. One specimen.

The single specimen has been attacked and worn away almost to the edge of the calice by incrusting nullipores, etc., so that the costae are scarcely visible. The edge of the calice is rather irregular, the polyp, wherever the nullipore is advancing, endeavouring to grow out above it.

The coral, however, can be at once distinguished from all previously described species by the characters of its primary septa. Owing apparently to the irregularity of the calice the paliform lobe is absent from two of the primary septa, and a third primary is distinctly bilobed towards the exterior. There is no sign of any epitheca, the junction of the formerly living extrathecal tissues and dead parts, however, being marked by a distinct thin pellicle, the edge of the advancing nullipore.

GENUS. *Antillia*, Duncan.

9. *Antillia sinuata*, n. sp. (Fig. 26.)

The corallum is widely open, trumpet shaped, somewhat bent and twisted. It is attenuate below, being drawn out gradually into a pedicle which in the specimen is bent sharply to one side. The pedicle is slightly compressed in a plane at right angles to its bend, but the calice above is more or less round with the edges rather sinuous.

The epitheca is very thin and transversely lined with the costae in places showing through; it is distant about 1 mm. from the true theca and extends up to about 3 mm. from its edge, above which the septa are 2—3 mm. exsert.

The septa are 102 in number, of which about half fuse with the columella, which closes in the oval axial fossa—8 mm. by 5 mm.—with a mass of twisted, tangled and anastomosing processes. The systems and cycles are not readily distinguished, as about the first 24 septa are almost equal in size; each of these generally possesses a paliform lobe, rising abruptly to a height of 2 mm. above the septal edge, then running horizontally inwards for 3—5 mm. and sloping steeply down to the columella, which is situated about 4 mm. below its upper edge. The septa of the fourth and fifth cycles are very irregular in length, and often are fused with the septa of preceding cycles, where the edge of the calice is depressed. The septa of the different cycles are nearly equally exsert and extend down to the epitheca as costae, which project for about 1 mm. from the theca. The edges of the septa are covered by low pointed teeth about 0.5 mm. apart and corresponding to these on the sides of the septa are a number of ridges.

Extreme height of the single specimen, 2.7 cm. Diameter of the calice, 3.5—3.9 cm. Diameter of the pedicle where broken, 3 mm.

Loc. Talili Bay, New Britain; 35 fathoms.

The specimen on which this species is founded has been broken off close to its attached base; in the fractured surface 12 septa and a broad columella are visible. Both exotheca and endotheca are scanty. The epitheca is attached to the corallum chiefly by means of the costal edges, and near the base has been much worn away by algal and worm growths.

The species is in its characters to some extent intermediate between *Antillia explanata* (Pourtalès) from Barbadoes and *Antillia constricta* (Brüggemann) from Borneo.

GENUS. *Tridacophyllia*, Blainville.10. *Tridacophyllia primordialis*, n. sp. (Fig. 7.)

The corallum is somewhat conical below, and attached by a stout pedicle with a slightly spreading base. The margin of the calice grows out into four thick, pointed branches. Of these, two arise opposite to one another and grow almost vertically upwards, the axial fossa between being generally somewhat elongated in the plane at right angles. Between these, in the latter plane, two more branches grow almost horizontally outwards, of which one is from the first usually much longer than the other; neither, however, attains the same length as the vertical branches. The outside of the corallum is marked by longitudinal rows of fine granules, which can be seen to be continuous with the costae and slightly exsert septa above.

The septa are thick with very finely granular sides and almost smooth edges. Their arrangement into cycles and systems is difficult to distinguish. Twelve extend to the axial fossa, of which one reaches to the top of each branch and two to its sides. Between these, three septa are usually intercalated so that four cycles would seem to be present. The interseptal loculi are shallow, being closed in below by endotheca. The axial fossa is elongated, rather narrow and open without any sign of a columella.

Extreme height of the largest specimen, 15 mm. Length of its vertical branches, 5 mm. and 5.5 mm. Length of the horizontal branches, 3.5 mm. and 1 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Five specimens.

A careful comparison of the specimens of this species with those of *Tridacophyllia cervicornis* (Moseley) in the British Museum has convinced me that this species is not a young form of it. The regular method of branching, the thickness of the branches, the considerable development of endotheca and the smooth edges of the septa in *Tridacophyllia primordialis* serve at once to distinguish between the two species.

In the youngest form, which is about 4 mm. high, the vertical branches are just beginning to grow out. Six septa run to the axial fossa; two of these run to the sides of each of the vertical branches, while the remaining two form ultimately the central septa of the two horizontal branches.

FAMILY. FUNGIDAE, Milne-Edwards and Haime.

GENUS. *Fungia*, Milne-Edwards and Haime.11. *Fungia ehrenbergii*, Leuckart.

Herpetolithus ehrenbergii, Leuckart, De Zooph. Corall. et gen. *Fungia*, p. 52, tab. II. (1841).

Fungia ehrenbergii, Dana, Zooph., p. 303, Pl. XIX., fig. 2 (1846).

There is one free anthocyathus, 10.2 cm. long by 4.4 cm. in breadth, which is referable to this well marked species. In addition there are four fixed specimens, which seem not improbably to belong to the same species.

Loc. Blanche Bay, New Britain; shore reefs.

GENUS. *Cycloseris*, Milne-Edwards and Haime.12. *Cycloseris hexagonalis* (Milne-Edwards and Haime).

Fungia hexagonalis, Milne-Edwards and Haime, Ann. des Sc. Nat., Ser. 3, t. ix., Pl. vi., fig. 2 (1848).

I have referred one adult anthocyathus without any scar of attachment and fifteen young specimens to this species. The young forms do not show the hexagonal characters of Milne-Edwards' specimens. A full description, however, will be given later¹.

Loc. Blanche Bay, New Britain; shore reefs.

FAMILY. EUPSAMMIDAE, Milne-Edwards and Haime.

GENUS. *Balanophyllia*, Searles Wood.13. *Balanophyllia profundicella*, n. sp. (Fig. 9.)

The corallum is almost straight, cylindrical, attached by a spreading base. The wall is devoid of epitheca, the living tissues covering about the upper third. The costae correspond to the septa, and are broad, subequal and little projecting with narrow intercostal spaces at the bottom of which the theca is but slightly perforated.

The calice is slightly oval in shape with a very deep, central, axial fossa. The septa are rather thin; their sides appear almost smooth, being covered with very minute granules, and their edges are entire. They are arranged in six systems and four cycles, all of which are complete. The primaries are prominently exsert, the quaternaries on either side of them and the secondaries projecting to about half their height. The primaries and secondaries are rounded at their summits and end almost perpendicularly by the axial fossa, the former extending furthest into the calice. The quaternaries fuse deep down in the corallum over the tertiaries and again over the secondaries, but the arrangement is not distinct and these septa appear often to be fused with them. The axial fossa is closed in below by the fusion of all the quaternaries very deep down in the calice.

Greatest height of the single specimen, 11 mm. Long diameter of the same, 5 mm.; short diameter, 4.1 mm.

Loc. Sandal Bay, Lifu; 40 fathoms.

This coral comes near *Balanophyllia parvula* (Moseley) from the Philippine Islands. It differs, however, in its more elongate form, deeper axial fossa and in the quaternaries on each side of the primaries being less enlarged.

GENUS. *Thecopsammia*, Pourtalès.14. *Thecopsammia regularis*, n. sp. (Fig. 8.)

The corallum is straight, almost the same diameter from base to calice, with a thin epitheca, extending over about three-quarters of its height and somewhat transversely marked with a well-defined upper edge. Above the epitheca costae are absent,

¹ J. S. Gardiner, "On the postembryonic development of *Cycloseris*," This volume, p. 171.

but the perforations of the theca are rather large and arranged in lines between the septa so that the edges of the latter are quite distinct, although nowhere projecting outside the thecal structures.

The calice is slightly oval in outline with a very deep elongated axial fossa; its edge has rather a ragged appearance from the slightly exsert septa. The septa are thick with narrow interseptal loculi; they are slightly perforated, and have their sides covered with small granular spines, which may form striae; their edges are bluntly lobed. They are arranged in six systems and four cycles, which gradually decrease in size. The quaternaries are incomplete, in some systems only two, viz. those on each side of one of the tertiaries, being present. The primaries and secondaries and the tertiaries also, if quaternaries are present, fuse with the columella, which is small, rather elongate in shape and formed of twisted lamellae, which may have one or two papilliform projections.

Extreme height of the largest specimen, 9.5 mm. Long diameter of the same, 5.5 mm.; short diameter, 4.3 mm.

Loc. Sandal Bay, Lifu; 40 fathoms. Two specimens.

This species differs from all previously described forms in the marked distinctness of its cycles of septa and in the secondaries and tertiaries being always larger than the quaternaries.

ZOOLOGICAL LABORATORY, CAMBRIDGE.

Aug. 9, 1898.

ON THE POSTEMBRYONIC DEVELOPMENT OF CYCLOSERIS.

By J. STANLEY GARDINER, M.A.

With Plate XIX. (Figs. 10—14) and Plate XX. (Figs. 15—24).

WHEN the alternation of generations in *Fungia* was first described by Stutchbury¹, the species of *Cycloseris*, then known, were placed under that genus or the genus *Cyclolites*. Milne-Edwards and Haime, in 1849, separated the genus *Cycloseris*², and, in 1851, carefully considered and described its species³. In the work last referred to, the genus is described as follows:—"Polypier simple, libre et sans traces d'adhérence, etc." In 1848, the same authors had previously described with a plate the septal arrangements in the different postembryonic stages of *Fungia patellaris* and *Fungia* (now *Cycloseris*) *hexagonalis*⁴, apparently believing that the development proceeded by similar stages in both species. Among the specific characters of the latter species, however, there is the statement "on ne distingue aucune trace d'adhérence même dans les très-jeunes individus⁵."

In 1879, Tenison-Woods described a young detached specimen of *Cycloseris sinensis*⁶, and further stated that a central disk on the under surface "is found on the lower part of every Australian specimen." Quelch considered that the form referred by Tenison-Woods to *Cycloseris sinensis* was more closely allied to *Cycloseris discus* and *Cycloseris freycineti*⁷; he neglected, nevertheless, to mention the fact that some of the Challenger specimens of that species have a very distinct scar on the aboral surface. Bassett-Smith, however, found among his corals from the Tizard and Macclesfield Banks young fixed forms of *Cycloseris tenuis* and *Cycloseris sinensis*⁸.

Considering that similar stages to those, so carefully and accurately described for

¹ "An Account of the Mode of Growth of Young Corals of the Genus *Fungia*," Trans. Linn. Soc., 1830, p. 494.

² Compt. rend. de l'Acad. des Sci., t. xxix, p. 72.

³ Ann. des Sci. Nat., Ser. 3, t. xv, p. 111.

⁴ Ann. des Sci. Nat., Ser. 3, t. ix, p. 37, Pl. vi.

⁵ Ann. des Sci. Nat., Ser. 3, t. xv, p. 111, and Cor. iii, p. 51.

⁶ Proc. Linn. Soc. of N. S. W., vol. iii, p. 20.

⁷ Reef-Corals, Challenger Reports, p. 122.

⁸ Ann. and Mag. Nat. Hist., Ser. 6, vol. vi, p. 446 (1890).

Fungia by Bourne¹, would ultimately prove to be of very wide distribution among the discoid forms of the Madreporaria, I carefully collected in Rotuma and Fiji all the fixed solitary reef-corals I found, upwards of fifty in number². All these were young *Fungia* with the exception of three or four, which seemed to me to be referable to the genus *Cycloseris*. On Dr Willey's return he kindly handed over to me two adult and twenty-four young specimens, which he had collected at low tide in rock pools at the base of the cliffs in Blanche Bay, New Britain. One of the adults I have referred to *Cycloseris hexagonalis*, while fifteen of the young specimens form an almost complete series to it. Two oval anthocyathi with very distinct scars on their aboral surfaces, evidently but recently detached from their anthocauli, are referable to another and probably new species of *Cycloseris*, which I do not propose to describe as it is not clear how far they have as yet attained their adult characters.

Cycloseris differs from *Fungia* as described by Duncan³ mainly in the fact that the theca in the former is imperforate. The septa of the species of the former, that I have examined, as compared with *Fungia*, are not at all, or not nearly so markedly ridged. The spines on their sides are arranged perfectly regularly, a line along each ridge, or in lines, which diverge in a similar manner to the ridges of *Fungia*⁴, and are not scattered irregularly over their surfaces. The theca further extends to a definite distance from the ends of the septa, and is not irregularly cut into between them as in *Fungia*. The synapticula are similar to those of *Fungia*, but do not extend so high above the theca, nor so far outwards between the septa. They do not in fact give nearly the same support to the corallum as those of *Fungia*.

The earliest fixed stage of growth or instar, that I have examined, is a young trophozoid⁵, 0.4 mm. in diameter by about the same in height (Fig. 10). It is attached to the aboral surface of a dead anthocyathus, which also has growing on it an anthocaulus. The base of the latter and the dead anthocyathus are both much overgrown by incrusting Polyzoa, Foraminifera, Sponges and Worm-tubes. The young trophozoid

¹ "On the Postembryonic Development of *Fungia*," Sci. Trans. Roy. Dublin Soc., vol. v. p. 205 et seq. (1893). Vide also "On the Anatomy of the Madreporarian Coral *Fungia*," Q. J. M. S., xxvii, p. 359, by the same author.

² A careful examination of these specimens has shown me that they very fully confirm Bourne's account so far as it applies to the gross structure of the skeletal parts in the different stages. It seems to me to be probable, though, that stalked individuals may be budded off from the free anthocyathus, where conditions are unfavourable for its continued growth, owing to incrusting organisms, sand, etc. These afterwards may themselves become anthocauli, detaching anthocyathi.

³ Jour. Linn. Soc. Zool., vol. xviii, pp. 141 and 149.

⁴ Comp. "Microscopic and Systematic Study of Madreporarian Types of Corals." By Maria Ogilvie. Phil. Trans. Roy. Soc., vol. clxxxviii, p. 83 et seq. fig. 37.

⁵ I have throughout used the terms proposed by Bourne for the different instars of *Fungia* (loc. cit., p. 206):—

Trophozoid. The individual Caryophyllia-like form developed directly from the ovum.

Anthoblasts. Buds from the trophozoid.

Anthocyathus. The discoid *Fungia* form, whether free or attached, developed from a trophozoid, or an anthoblast.

Anthocaulus. The pedicle, which carries the anthocyathus, and after the detachment of the latter usually gives rise by re-growth to a new anthocyathus.

The term "instar" was advocated by Sharp (Camb. Nat. Hist., vol. v, p. 155) for the successive stadia of insects. It seems to me that the term may be very usefully applied here to imply simply a stage of growth.

is straight and incrustated by a Polyzoan right up to the edge of the calice, which is accordingly bent slightly inwards. There are seven septa at nearly equal distances from one another round the calice, but six are subequal, broad, thick and covered with rough spines while the seventh is comparatively narrow and smooth; the former are termed throughout the primaries. In the centre of the calice is a single prominent, rough papilla—the columella.

The next two instars are also attached to the aboral surface of the same dead anthocyathus. The second is about 0.7 mm. in diameter by 0.5 mm. high, and was apparently covered up to the edge of the calice by an incrusting sponge, which grew to some extent over its opening. The septa are difficult to distinguish, but ten or eleven seem to be present, some of which are very narrow and rudimentary; the columella is deeper and less prominent than in the preceding instar. Attached close to the base of this form is another trophozooid of almost the same size, which has been completely killed by the same sponge; it appears to have ten septa, subequal in size.

The third instar (Fig. 11) is straight, about 1.2 mm. in diameter by 0.7 mm. in height. Fourteen septa are present, which cannot however be distinguished into cycles. Two are extremely thin and rudimentary, while four others do not appear to fuse with the rest in the centre of the calice; the remainder vary in thickness and are slightly exsert with rough granular spines. The axial fossa is deep, about 0.4 mm. broad and closed in below by the fused septal trabeculae from which project three large, rough papillae, one of which lies almost centrally, and is, I believe, the true columella. The wall is covered on the outside by an incrusting alga; it appears to be in some places double and to consist of a fused theca and epitheca.

The above forms are, I believe, true trophozooids, directly developed from the ovum. In many of the succeeding instars it is impossible to see whether the young form has been developed from a trophozooid, an anthoblast (if such exist), or by the re-growth of an anthocaulus. The development of the skeletal parts appears to follow along the same lines so that I shall briefly describe them, mentioning to which category each form seems to belong.

The next instar (Fig. 12) has 28 septa. It is the re-growth of a nearly straight anthocaulus from which three anthocyathi—the lower two represented by rings—appear to have separated at the heights of 4, 6.5 and 8 mm. above its attached base. The anthocaulus where the last anthocyathus separated is about 3.5 mm. in diameter while the young anthocyathus is still straight, about 1 mm. high by 2 mm. in diameter. The six primary septa can be clearly distinguished, being thicker, more spinulose and markedly broader than the rest. The remainder vary considerably, one of the secondaries being almost as thick and exsert as the primaries, but clearly joined at its sides by two of the tertiaries. The axial fossa is large and closed in below by a trabecular columella, with which most of the septa appear connected.

The commencement of the horizontal growth is clearly seen in another specimen (Fig. 13), formed by the re-growth of an anthocaulus, from which one anthocyathus has separated. The calice is about 7 mm. in diameter while the stem is 3.5 mm. Four cycles of septa are complete and there are also 8 septa of the fifth cycle. The primaries are quite distinct while the quaternaries are fused to the tertiaries, which are

themselves fused to the secondaries. A few synapticula—formed apparently by the fusion of spines on the sides of the septa—are found close to the axial fossa, which begins to attain its adult appearance, closed in below by a spongy, trabecular columella with small, blunt, papilliform projections.

Another anthocyathus (Fig. 23), about 13 mm. across the calice, on an anthocaulus with three rings, attached to the same dead Cycloseris as the first three instars, shows the still further horizontal growth. Four cycles of septa are complete and the fifth nearly so; all are slightly exsert.

The theca is imperforate in all the specimens; it is formed in the same way as in *Fungia* by the fusion of the swollen-out sides of the septa. Fresh centres of calcification appear to be intercalated as the circumference of the calice becomes greater and the distance between the septal ends is increased; these give rise to the fresh cycles of septa. Some of the septa in the last instar are over 1 mm. exsert while in the adult none project for more than 3 mm. beyond the theca. The synapticula vary extremely, but in no specimens extend within 2 mm. of the edge of the theca.

The remaining fixed specimens are (i) an anthoblast (or trophozoid), 13 mm. in diameter, but very irregular, with 4 complete cycles of septa and the fifth cycle nearly complete (Fig. 24); (ii) an anthocyathus on an anthocaulus, attached to a bud from a dead free form, 17 mm. in diameter, with 5 cycles and a few septa of the sixth (Fig. 22); (iii) an anthocyathus on an anthocaulus with two rings, 26 mm. in diameter, with 6 cycles; (iv) an anthocyathus on a trophozoid, 31 mm. in diameter, with 6 cycles and a few septa of the seventh (Fig. 21); (v) a very irregular anthocyathus on an anthocaulus, 37 mm. in greatest diameter, with 6 cycles and in places the seventh complete also (Fig. 20).

The smallest of these forms (Fig. 24) is 19 mm. high with a relatively deep calice, and attached by the side of its stalk. From a comparison with the instars of *Fungia*, which I collected myself, I am inclined to believe that it is rather an anthoblast than a trophozoid. In all the rest at the top of the stalk immediately under the horizontal anthocyathus there is a distinct pitted ring (Fig. 21 *b*), where the break would ultimately have taken place. Above this the corallum is white and translucent while below it is dark and opaque, showing that it is to some extent changed. The part between this and the top ring is in no case overgrown by organisms, and it seems to be probable that the body-wall of the polyp formerly covered it. The detachment of the anthocyathus would seem, indeed, to be effected in precisely the same way as Bourne has described for *Fungia*. The costae vary, in some being almost smooth ridges and in others having the adult characters.

The smallest free anthocyathus is slightly oval in shape, 20 mm. by 17 mm. in diameter (Fig. 19). On the aboral surface the scar is well marked, but the opening from the exterior into the coelenteron has been closed by corallum, owing apparently to thickenings of the sides of the septa. A slightly larger but irregular form, 23 mm. in greatest diameter, has the opening still complete (Fig. 18). The broken edges of the septa have an extremely opaque, white colour; and above them the septa and trabecula of the columella appear to have been thickening so as completely to close in the coelenteron. The scar is somewhat oval, 6.5 by 5 mm. in diameter, and in it the

septa of the first four cycles can be distinguished (Fig. 14). The aboral surface round the scar has been much overgrown by Polyzoa, and in the smaller free form the corallum is very dense round it so that the costae cannot be traced into its septa. Another specimen triangular in shape, 25 mm. in diameter, has the scar very distinct with the costae quite continuous into its septa (Fig. 17); it has also been overgrown by organisms except for a few mm. round the edge. A larger anthocyathus 5.3 mm. in diameter has the scar still distinct with the septa quite visible (Fig. 16); otherwise its characters are those of the adult. The oral and aboral surfaces of the latter are represented in Figs. 15 *a* and 15 *b*. The scar has been completely obliterated and covered over by corallum, its position being merely indicated by a slight opacity.

The striking resemblances between the developments of Cycloseris and Fungia cause a doubt as to the distinctness of these two genera. The differences, mentioned above, between them, are undoubtedly worthy of generic rank, but the two forms are evidently extremely closely allied. The primary septa in Cycloseris are very definitely six in number, the secondaries not reaching quite so far into the calice and having the tertiaries fused to them. In the youngest instar that I examined there are six thick, subequal septa, and in the youngest Fungia found by Bourne "twelve septa are present of which six are distinctly larger than the others." In nearly all the solitary imperforate Madreporaria, which are the more ancient in respect to time, six septa are very strongly marked, and must be regarded as the primaries. In many forms too only six septa are present, and these so far as is known are always entocoelic. The formation of twelve septa simultaneously in *Astroides calycularis*, of which six later get larger, I can only regard as a condensation of the stages of its development¹. It seems to me that primitively there are six entocoelic septa, a number that corresponds with the twelve mesenteries found in the embryos of many of the Actiniaria, and in the embryo also of Euphyllia² at the same stage apparently as the fixing larva of *Astroides calycularis*.

In conclusion, I wish to thank Mr Adam Sedgwick, Dr Willey and others for their kindly interest and advice.

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¹ Vide "Développement des Coralliaires." H. de Lacaze Duthiers. Arch. de Zool. Exper. et Gen., I. and II. (1872 and 1873). Also G. von Koch, Mitt. aus der Stat. Zool. Neapel, III. 1882, p. 284.

² "The Newly-Hatched Larva of Euphyllia." A. C. Haddon. Sci. Proc. Roy. Dublin Soc., p. 117, 1890.

EXPLANATION OF PLATES XIX. AND XX.

PLATE XIX.

(The small numerals at the sides of several of the figures refer to the cycles of septa.)

FIG. 1. *Desmophyllum tenuescens*, n. sp.

(a) Profile view of the corallum ($\times 3\frac{1}{4}$). The stalk is covered with small, low granules, the costae only extending for about 1.5 mm. below the edge of the theca.

(b) The calice from above ($\times 4$). Primary, secondary and tertiary cycles of septa are present, the two former nearly meeting in the centre of the oval axial fossa.

FIG. 2. *Rhizotrochus levidensis*, n. sp.

(a) Profile view of the corallum ($\times 3$), showing the large radicle and two small rootlets. The epitheca is concentrically marked below, but covered above by incrusting organisms.

(b) The calice from above ($\times 3\frac{1}{2}$). The axial fossa is large and deep but closed in below by the fusion of the primary septa, of which the two, situated at its ends, arise rather deeper and are less projecting.

FIG. 3. *Thecocyathus minor*, n. sp.

(a) Profile view of the corallum ($\times 4\frac{1}{2}$). The epitheca extends almost to the margin of the calice and is transversely marked. Near the attached base it has been eaten away by boring organisms and the costae are exposed.

(b) The calice from above ($\times 7$). The primary, secondary and tertiary septa are complete; the quaternary are generally represented by two septa in each system on opposite sides of one of the tertiaries. The pali of the primary septa are smaller than those of the secondaries, while in front of the tertiaries bilobed pali are found where quaternaries are present. The columella ends above in blunt papillae with difficulty distinguishable from the pali. The quaternary septa are not quite so completely developed as the figure portrays.

FIG. 4. *Paracyathus parvulus*, n. sp.

(a) Profile view of the corallum ($\times 3$). The lower part is incrustated by a nullipore, while a Polyzoon has grown up on one side to within a few mm. of the edge of the calice.

(b) The calice from above ($\times 6$). Three cycles of septa are complete, and in some of the systems quaternaries are found on opposite sides of one of the tertiaries.

FIG. 5. *Paracyathus lifuensis*, n. sp.

(a) Profile view of the corallum ($\times 3$). The costae are subequal broad ridges extending to the somewhat enlarged base of attachment which is overgrown by nullipores, worm-tubes, etc. No epitheca can be distinguished.

(b) The calice from above ($\times 3$). The pali in front of the tertiary septa are often bi- or tri-lobed, and are much larger than those of the primaries and secondaries, which themselves project further into the calice.

FIG. 6. *Lithophyllia palata*, n. sp.

(a) Profile view of the corallum ($\times 2$). The base and sides of the corallum are much overgrown by an incrusting nullipore, some of the branches of which can be seen to the left. In consequence of this the costae are, on the side shown in the figure, inconspicuous. The primary septa are much larger and more exsert than the others, and in front of four of them straight, paliform lobes can be seen.

(b) The calice from above ($\times 2$). Owing probably to the irregularity of the calice, paliform lobes are only found in front of four of the primary septa instead of the whole six as normal. The first three cycles of septa are complete; the quaternaries are nearly so, and in some of the systems septa of a quinary cycle are found.

FIG. 7. *Tridacophyllia primordialis*, n. sp.

(a) Profile view of the youngest corallum ($\times 2$). The two vertical branches are commencing to grow out, and the costae are in this stage especially well marked. At the base a small worm-tube is attached.

(b) Profile view of another young corallum ($\times 2$), in which one of the vertical branches is much longer than the other.

(c, d and e). Profile views of older coralla (c and d $\times 2$, e $\times 3$), showing variations in the mode of growth. Four cycles of septa are present, of which the six primaries extend one to the ends of each of the horizontal, and two to the sides of each of the vertical branches. The corallum (e) is partially covered at its base by an incrusting Polyzoon.

FIG. 8. *Thecopsammia regularis*, n. sp.

(a) Profile view of the corallum ($\times 3$), showing the high extension of the epitheca, above which is seen the theca with its perforations in lines between the septa. No costae are present.

(b) The calice from above ($\times 6$). The first two cycles of septa are complete and fuse with the columella, which is formed of twisted lamellae. The tertiaries are likewise complete and there are at least two quaternaries in each system on opposite sides of one of the tertiaries. (The bluntly lobed character of the septal edges is not clearly shown.)

FIG. 9. *Balanophyllia profundicella*, n. sp.

(a) Profile view of the corallum ($\times 2\frac{1}{2}$). The costae are subequal and well marked, the theca being little perforated between. The lower part of the corallum is much overgrown by calcareous organisms and there is no epitheca.

(b) The same from above ($\times 5$). Three cycles of septa are complete and the fourth nearly so. The quaternaries fuse over the tertiaries and again over the secondaries, joining then deep down in the calice with the primaries so as to close the axial fossa below.

FIGS. 10—24. Various stages in the postembryonic development of *Cycloseris hexagonalis*, Milne-Edwards and Haime.

FIG. 10. Oral view of a young trophozooid ($\times 25$) with seven septa, of which six are much broader and fuse below with the columella. The edge of the corallum appears smooth and slightly bent inwards owing to incrusting organisms growing over its sides.

FIG. 11. Oral view of a slightly older trophozooid ($\times 25$) with fourteen septa, of which twelve—the primaries and secondaries—are conspicuously the larger. The sides of the corallum are overgrown by an incrusting sponge, which extends up to the edge of the calice, and gives it a smooth, regular appearance.

FIG. 12. Commencing regrowth of an anthocaulus to form a new anthocyathus.

(a) Profile view ($\times 3\frac{1}{2}$), showing two rings of detachment of previous anthocyathi. The top is flat owing to the recent separation of a third anthocyathus, and in its centre can be seen a new anthocyathus being formed by its regrowth.

(b) Oral view ($\times 5$). After an old anthocyathus has become detached, a new anthocyathus commences to grow out from the centre of the scar on the anthocaulus, the outer part dying. Subsequently the stalk of the new anthocyathus broadens and attains about the same breadth as the anthocaulus below it. Many of the septa of the bud can be seen to be in the same vertical plane as those broken off, where the previous anthocyathus became detached, the septa of the bud being continuous with those left in the anthocaulus.

FIG. 13. Oral view of an anthocyathus formed by the regrowth of an anthocaulus ($\times 6$), showing the commencement of the horizontal growth. Four cycles of septa are complete: of these the quaternaries fuse with the tertiaries and the latter with the secondaries, while the primaries run straight to the axial fossa, which is closed in below by the relatively large, papilliform columella.

FIG. 14. Scar on the aboral surface of the recently freed anthocyathus shown in Fig. 18 ($\times 3\frac{1}{2}$). The corallum is still open between the oral and the aboral surfaces, but the septa, of which four cycles can be seen in the scar, have begun to thicken at their sides. Their edges are extremely white and opaque, the corallum having evidently undergone a change which probably brought about the separation of the anthocyathus.

PLATE XX.

(The figures on this plate, unless otherwise precisely stated, are all of the natural size.)

Figures 15—24 relate to *Cycloseris hexagonalis*.

FIG. 15. An adult anthocyathus.

(a) Oral view. The six primary septa except at the ends of the axial fossa can be seen to project slightly further into the calice than the secondaries. The septa of higher cycles can be seen in places very distinctly fusing with those of the cycles below them.

(b) Aboral view. The corallum has a well marked imperforate theca, beyond which the septa are nearly equally exsert. In the centre is a slightly opaque area covered with low spines where the anthocyathus originally separated from its stem.

FIG. 16. Aboral view of the next oldest anthocyathus, in which the scar is still very conspicuous. The costae are well marked rows of blunt spines, extending almost to the scar.

FIG. 17. An aberrantly shaped free anthocyathus with six cycles of septa.

(a) Oral view.

(b) Aboral view showing the scar still very distinct. The whole surface has been much overgrown and killed except near the edges by incrusting organisms. Some of the costae, however, can be directly traced into the septa of the scar.

FIG. 18. Oral view of the young free anthocyathus, the scar of which is represented in Fig. 14. Five cycles of septa are complete.

FIG. 19. Aboral view of the smallest free anthocyathus. The corallum is nearly closed in below, but the edges of the septa in the scar are still very ragged and distinct.

FIG. 20. A large irregular, attached anthocyathus.

(a) Oral view. Six cycles of septa are complete and on the broad side the seventh cycle also.

(b) Aboral view. In the centre is the stem, to which the anthocyathus is attached. It is an anthocaulus, from which one anthocyathus has already separated, the ring left by which can be seen in places.

FIG. 21. An anthocyathus almost ready apparently to detach itself from its stalk.

(a) Oral view showing six complete cycles of septa.

(b) Aboral view. In the centre is the stalk, round which immediately under the horizontal outgrowth can be seen a distinct pitted ring, where the anthocyathus will subsequently be detached.

FIG. 22. Profile view of a young anthocyathus, attached to an anthocaulus, which is itself fixed on a dead free anthocyathus, from which it was probably in the first place budded. There is one ring of detachment of a former anthocyathus.

FIG. 23. Profile view of a still younger anthocyathus on an anthocaulus with three rings. Even at this size a trace of the pitted ring, where the anthocyathus will subsequently be detached, is visible. The anthocaulus is attached to a fragment of a dead free anthocyathus, to the under surface of which the three youngest trophozooids, two of which are represented in Figs. 10 and 11, are attached.

FIG. 24. A young anthoblast (trophozooid?) with four cycles of septa complete.

(a) Profile view ($\times 1$).

(b) Oral view ($\times 2\frac{1}{4}$).

FIG. 25. *Deltocyathus ornatus*, n. sp.

(a) Aboral view ($\times 2\frac{1}{4}$). The costae commence as rows of low granules, gradually passing from a slight prominence in the centre into broad rounded ridges towards the exterior. The primary, secondary and quaternary septa are equally exsert, while the tertiaries—twelve—project considerably further.

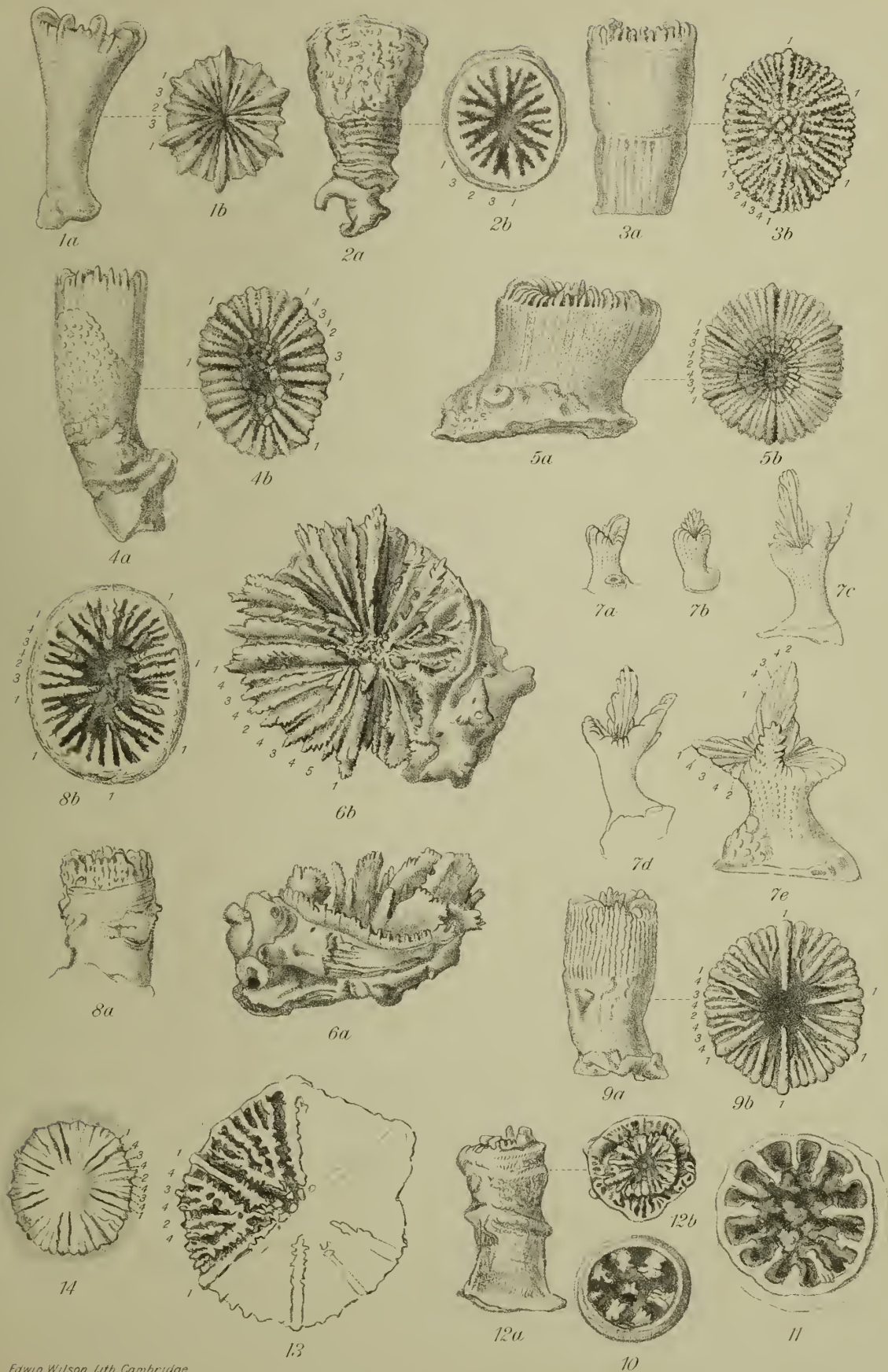
(b) Oral view ($\times 2\frac{1}{4}$). The primary and secondary septa closely resemble one another, but can be seen in most of the systems to run much deeper into the corallum and to have less elongated paliform lobes than the tertiary septa, which are much more exsert. In places the quaternary septa can be seen bending in towards the tertiaries with

which they fuse deeper in the corallum. (The exsert portions of two of the tertiary septa at the top right-hand corner of the figures are broken.)

FIG. 26. *Antillia sinuata*, n. sp.

(a) Profile view of the corallum. The epitheca is very thin and extends up to about 3.5 mm. from the edge of the calice. Below it has been worn away by various organisms and the costae are exposed. The pedicle of the corallum is broken.

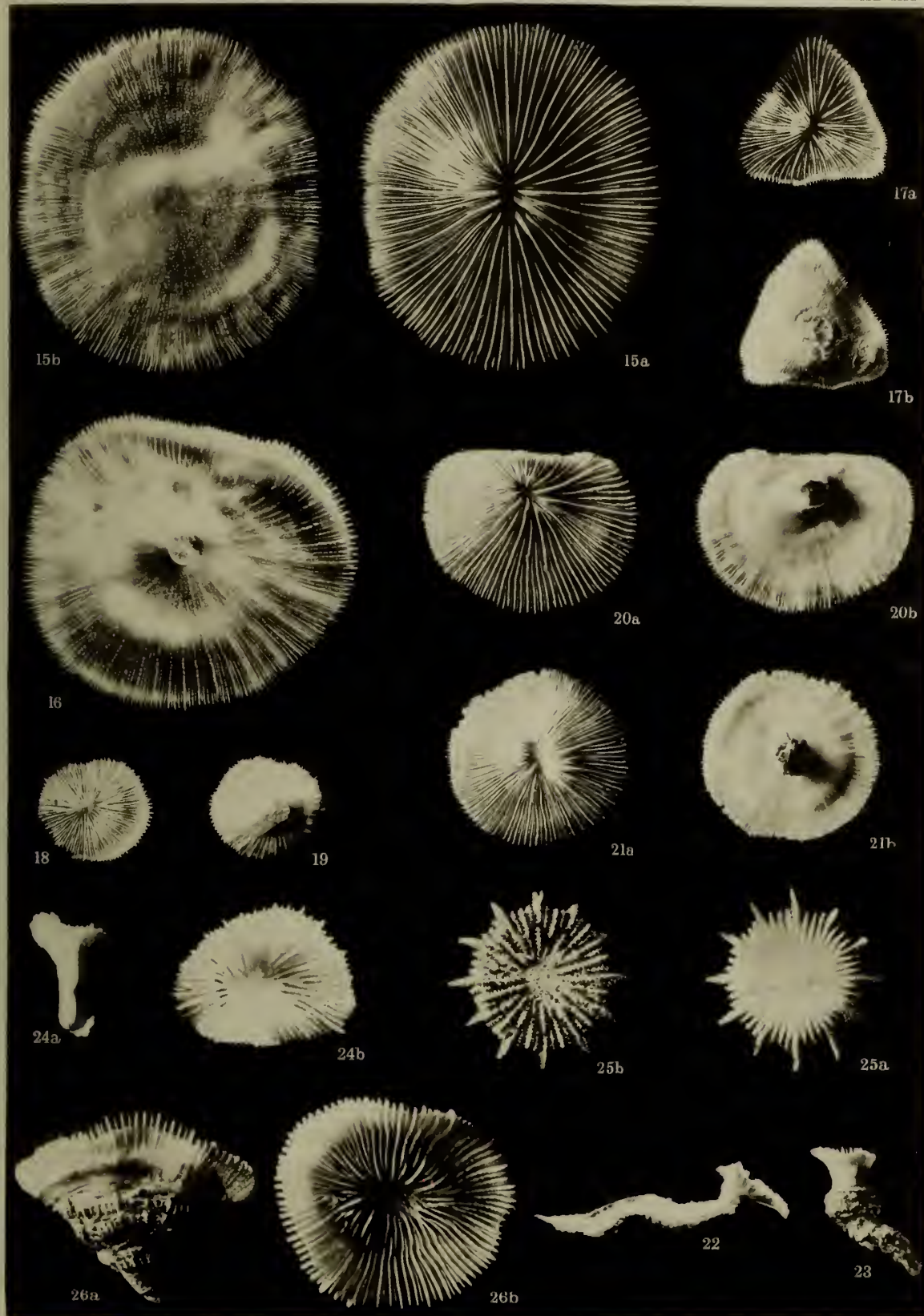
(b) The calice from above. There are 102 septa, the lower cycles of which are not readily differentiated. The columella is a mass of tangled and anastomosing processes arising from about half of the septa.



Edwin Wilson, Lith. Cambridge.

GARDINER.

SOLITARY CORALS AND DEVELOPMENT
OF CYCLOSERIS.



ON A COLLECTION OF EARTHWORMS FROM NEW BRITAIN,
THE SOLOMON ISLANDS, THE NEW HEBRIDES, AND THE
LOYALTY ISLANDS.

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Prosecutor and Assistant Secretary of the Zoological Society.

With Plate XXI.

THE following pages relate to the Collection of Earthworms formed by Dr Willey among the islands mentioned in the title. A very considerable number of these worms were in an excellent state of preservation; others on the contrary were softened. In the case of the latter I have not thought it advisable in every case to publish a description. I have taken this course on account of the fact that I could not be quite certain as to their identity or non-identity with other species. It appears to me that little is gained by publishing an account of a species which cannot, from the nature of the case, be sufficiently full to permit of a confident statement as to its specific characters, unless indeed new details of anatomical importance should turn up during the examination. This applies also to immature examples, of which Dr Willey's collection contained a good number. Such incomplete descriptions would only serve to exercise the ingenuity of workers coming after me, who might consider it to be their duty to identify species with those briefly described by myself; no advantage to science would be gained by taking this step. I shall therefore deal in this memoir only with those species which I can, I believe, fully identify as new forms or as species already known.

The area where Dr Willey collected the species to be described here is a large one, and has not been much investigated from the point of view of its earthworm inhabitants. It may be convenient before adding my own contributions to the knowledge of the Earthworms of the Polynesian region (of Lydekker) and of the islands adjacent to New Guinea, to refer briefly to what has already been done.

I shall consider only New Guinea and the islands which lie to the west of Long. 150, below the equator and to the north of New Zealand.

The first accounts of earthworms from this tract of the earth's surface are contained in the memoir of Kinberg entitled "Annulata nova" which was based upon the collection made during the voyage of the Swedish vessel "Eugenia¹." These are perfectly unrecognisable and need not detain us; they are *Lumbricus tahitana* (from Tahiti), which is possibly a Cryptodrilid: *Pheretima montana* from the same island, which is clearly a Perichaetid, and probably a *Megascolex*, judging from the length of the clitellum. Grube described in the "Voyage of the Novara²" *Perichaeta taitensis* from Tahiti, and *P. subquadrangula* from Viti. The former of these species Rosa³ divided into two to which he gave the names of *P. grubei*, and *P. novarae*. The latter species of Grube may be my *P. vitiensis*⁴. From the island of Upolu in the Samoa group I described some years since *P. upoluensis*⁵. From New Guinea I described *P. forbesi*⁶, and subsequently Michaelsen⁷ founded the species *P. neoguinensis*. More recently still Rosa⁸ has described a variety of Michaelsen's species as well as *P. lorise* and *P. papua* from that same island. Dr Benham⁹ examined some of Dr Willey's collection and founded upon the material sent to him from New Britain the species *P. novae-britannicae*, *P. sedgwickii* and *P. arturi*.

The very widely distributed *P. indica* was found by myself in a gathering of earthworms from New Caledonia¹⁰, and from that same island Perrier described *Acanthodrilus unguatus*¹¹ (which is not perhaps separable from my *A. layardi*). I have also recorded the ubiquitous *Eudrilus eugeniae*¹² from New Caledonia. *Dichogaster damonis*¹³ is a Fijian species. The genus *Benhamia* is represented in New Guinea by *B. malarmata*¹⁴.

In the present communication I describe as new forms the following species:—

Perichaeta pacifica, New Britain.

Perichaeta solomonis, from Narowol and New Georgia (Rubiana) of the Solomon Archipelago.

Perichaeta esafatae, Esafate, New Hebrides.

I also am able to extend the range of *Perichaeta upoluensis* to the New Hebrides, of *Perichaeta malamaniensis* to the New Hebrides and Loyalty Islands, and of *Perichaeta lorise* to the Solomon Islands.

In addition to these species of *Perichaeta* the collection contained examples of *Benhamia* from New Britain and from Lifu which I did not further identify.

¹ In Övers. k. vetensk. Ak. Handl., 1866, p. 97 et seq.

² Anneliden in Novara Expedition.

³ Ann. k. Hofmus. Wien, vi. 1891, pp. 35—37.

⁴ Ann. and Mag. Nat. Hist., 1892, p. 131.

⁵ Proc. Roy. Soc. Edinb., xiv. p. 174.

⁶ P. Z. S., 1890, p. 65.

⁷ Arch. f. Naturg., 1892, p. 229.

⁸ Ann. Mus. civ. Genova (2), xix. p. 60 et seq.

⁹ Journ. Linn. Soc., xxvi. p. 198 et seq.

¹⁰ P. Z. S., 1886, p. 299.

¹¹ Nouv. Arch. du Mus., 1872, p. 85.

¹² Loc. cit., p. 168.

¹³ Quart. Journ. Micr. Sci., xxix. 1889, p. 251.

¹⁴ Rosa, Ann. Mus. civ. Genova (2), xix. p. 57.

I found myself obliged to abandon the task of attempting to distinguish these small *Benhamias*. One species from Lifu is a slender form with clitellum extending over segments XIII—XX with ornamented penial setae, a single oviducal pore and the usual internal characters. It is about 30—35 mm. long and appears to have no genital papillae. It is difficult to differentiate from or to identify with other small species.

There were many specimens of *Pontodrilus* from the Isle of Pines in the Loyalty group.

It is clear therefore, that, as far as our present knowledge goes, the prevailing earthworm genus of this part of the world is *Perichaeta*. Out of a total of sixteen species known with certainty as recognisable species found within this region and not obviously (?) imported forms—like *Perichaeta indica* and *Eudrilus eugeniae*—no less than thirteen are *Perichaetas*. But nothing further can be said in favour of a Polynesian region, such as Mr Lydekker urges, from the point of view of earthworms. So far as earthworms are concerned there is, it appears to me, a great Oriental region which embraces Australia and Polynesia on the one hand, and the whole of the Malay Archipelago and India on the other. This cannot be profitably subdivided.

PERICHAETA NOVAE-BRITANNIAE, Benham.

P. novae-britannicae, Benham, Journ. Linn. Soc. Zool., xxvi. p. 199.

Dr Benham has given a very full account of the anatomy of this species; and I have practically nothing to add to his account. It is clearly the commonest species of New Britain, judging by the numbers contained in Dr Willey's collection. Dr Benham's figure of the papillae in the neighbourhood of the male pores does not however seem to me to exhibit their characters accurately. They are not glandular looking areas as are generally the copulatory papillae of these worms. In the specimens which I examined they were invariably sharp depressions in the body-wall (Fig. 9), looking as if they played the part of suckers rather than adhesive papillae. I may also observe that the species grows to a larger size than might be inferred from Benham's description. I have examined a well preserved example of 160 mm. by 8 mm. in breadth.

PERICHAETA SEDGWICKII, Benham.

P. sedgwickii, Benham, loc. cit., p. 201.

Dr Benham described an exceedingly remarkable character in this species. Instead of the two normal caeca of *Perichaeta*, wanting in so few species, and placed always, or in the vast preponderance of species, in the XXVth or XXVIIth segment, Benham

has mentioned in this species a single caecum placed rather further forward. This is, as I believe, an absolutely unique character in this genus. I was therefore particularly careful to endeavour to confirm or to deny Benham's statements. I may say that I found this single unpaired caecum in three specimens which I thought sufficient to dissect for the purpose; there can therefore I think be no doubt that we have here a genuine specific character and not a mere abnormality as might be suggested. The single caecum is in its characters precisely like one of the two caeca where there are two. It has the same somewhat crinkled aspect that the caeca of *Perichaeta* possess; and it is not unusually large so as to suggest a fusion between a medianly approximated pair.

One fact in the structure of this species has been apparently overlooked by Benham. He does not refer to the existence of genital papillae except a pair on either side of the male pores. These papillae (Fig. 3) are by no means always distinct; but in one of the individuals which I studied were quite obvious although forming somewhat faint impressions upon the body-wall. These papillae, though faintly outlined, are very large and occupy nearly the whole of the available space on the ventral side of the body. They occur both in the neighbourhood of the male pores and of the spermathecae. On each of segments XVII, XIX, XX, XXI, are a pair closely approximated to each other on the ventral surface of those segments, in front of the line of setae. In addition to these the XVIth to the XXth segments possess a pair of papillae situated to the outside of the set that has just been described. These latter are in fact on a line with the male pores. These papillae lie partly behind and partly in front of the setae of their respective segments, overlapping them in front. Those of the XVIIth¹ and XVIIIth segments are more intersegmental in position, extending in each case a little way on to the following segment; they remind one much of the articular surfaces for ribs on two adjacent vertebral centra. It is these papillae only that Benham has referred to in his account of *Perichaeta sedgwickii*. The papillae in the neighbourhood of the spermathecal pores are placed on segments X—XIII. On each of these segments are a pair of ventrally placed papillae lying in front of the row of setae.

The other characters of the worms that I refer to *Perichaeta sedgwickii* agree so absolutely with the description given by Benham that I cannot doubt that they are specifically identical. Here however is a character, not always obvious, that when missing or apparently missing might have easily led to the creation of a new species, if but one example had been under observation.

PERICHAETA MALAMANIENSIS, Benham.

P. malamaniensis, Benham, loc. cit., p. 213.

Dr Benham's two species *Perichaeta arturi* and *P. malamaniensis* evidently come very close together. They agree to differ from all species of which at any rate we have adequate knowledge by the existence of a complex copulatory apparatus, which

¹ The outer papillae of segment XVII are not visible in the specimen figured.

seems to be a further specialisation of a terminal sac of varying size into which the duct of the spermiducal gland opens in many other species. In fact we have in this genus an interesting series of stages in the evolution or degradation of this organ. In many species the duct of the spermiducal gland opens directly on to the exterior, in some cases not even widening before its aperture; in other cases it gets wider towards the external pore. The next stage is seen where the duct opens into a small sac before opening on to the exterior; in other species again this sac is larger and larger; and finally we have the two forms under consideration in which the sac exists, is large and is furnished with a protrusible or eversible penis. These two species furthermore agree in the fact that the spermiducal gland is bi- or even trilobed, each division then having its own separate duct. It does not seem to me to be very plain that there is much difference in the copulatory apparatus of *P. arturi* and *P. malamaniensis*. But one point of difference is noted by Benham and that is the form of the spermathecal appendix. In *P. arturi* it is long, longer than the main pouch, while it is small in *P. malamaniensis*. For this latter reason I refer examples of a worm which is certainly either one species or the other to *P. malamaniensis*; they were collected in New Britain on Gazelle Peninsula, on the Isle of Pines (New Caledonia), at Lifu and at Mare in the Loyalty Islands, and finally at Esafate in the New Hebrides. The original description of *P. malamaniensis* is of specimens from the Philippines.

PERICHAETA LORIAE, Rosa.

P. loriae, Rosa. Ann. Mus. civ. Genova (2), XIX. p. 61.

This form was described by Rosa from New Guinea. I have seen two examples from Guadalcanar in the Solomons. I have only to add to Dr Rosa's account that in one at any rate of these two individuals there were no setae on segments XIV and XV. In the other I observed them upon XV. In both examples there are setae upon segment XVI; but the glandular modification of the integument does not extend so far as the seta row.

PERICHAETA UPOLUENSIS, F. E. B.

P. upoluensis, Beddard. Proc. Roy. Soc. Edinb., XIV. p. 174.

Nearly twelve years ago I described from Upolu in the Samoa group of Islands a *Perichaeta* which I believed, and believe, to be a distinct form. The species was mainly characterised by the character and distribution of the genital papillae. Dr Willey collected four examples of this same species at Esafate or Sandwich Island in the New Hebrides group. Distant though this Island is from Upolu, I consider

that we have to do with the same species. I cannot, after carefully comparing the new specimen with those from Upolu (one entire specimen I fortunately possess), see the slightest reason for separating them, although as will be seen I am able to add some details to my original account of this *Perichaeta*. *Perichaeta upoluensis* is a species which varies considerably in size. The largest of the examples collected by Dr Willey measures 166 mm. in length and consists of about 110 segments. The smallest example, but equally mature as regards the development of its sexual organs, is only 92 mm. in length and consists of but 95 segments.

This worm is characterised by a purplish tinge upon the dorsal surface. The dorsal pores commence between segments X and XI.

As I have already mentioned, the most characteristic feature of this species is the number and arrangement of the copulatory papillae. These show some variation from specimen to specimen, with of course the same general disposition. The papillae are in every case very small contrasting with those, for example, of *Perichaeta sedgwickii* just described.

Their characteristic feature (Fig. 2) is that a number of segments immediately following the clitellum have a single median papilla. They are not paired. I shall now describe the arrangement of the papillae in detail in the four specimens; this is by no means a waste of time or space, since species of *Perichaeta* are occasionally mainly or even entirely to be discriminated by the number and the arrangement of their papillae. And since furthermore some species have been described as to these organs from a single example. It is highly important therefore to take note of the variations which these structures exhibit. From a detailed account of the variations a general notion of the characteristics of the species can be obtained.

In one specimen there is a single papilla on each of segments X, XVII—XXI; and in addition to these median papillae two near to each male pore. One of these lies to the inside and above the pore, the other to the outside. In a second specimen there is no papilla upon segment X. But the median papillae in the neighbourhood of the male pores are increased by an additional one upon segment XXII. Moreover that upon segment XXI was double. The two papillae close to the male pores are increased in this individual to three.

In specimen No. 3 I did not detect a papilla upon segment X. But there were six on the segments following the clitellum, i.e. on XVII to XXII. A triangle of a papillae surrounded each male pore.

In the largest individual of this species there are only five papillae of the median series, thus showing that it is not always possible to assume that the largest individuals are more completely mature than smaller specimens. There was no papillae on X and only two in the immediate neighbourhood of the male pores. In my original account of this species I described a median papilla upon segment IX not upon segment X, as in one of the individuals collected by Dr Willey. It occurred to me that I might easily have made a mistake, and fortunately I have by me one of the specimens from which that description was compiled. I find on re-examination that I did not fall into an error in this matter.

The clitellum fully occupies segments XIV—XVI. I could not find any setae upon it.

As to the setae of this species they do not differ markedly in size on different segments of the body or on different parts of the same segment. Their numbers on certain segments are as follows:

X, 46; XIII, 50; XVII, 55; XXV, 54.

I counted 7 setae between the male pores.

As to the internal structure of this species of *Perichaeta*, the following facts appeared to me to be specially noteworthy.

There are five stoutish septa lying behind the gizzard, the last of which separates segments XIV and XV.

The last of the contractile "hearts" lies in segment XIII.

The gizzard is large and appears to lie in segments VIII, IX; I could find no septum separating these segments. The intestine begins in segment XVI. The caeca arise in XXVI and extend forward through three segments.

In the region of the intestine I found numerous racemose "lymph glands," lying as usual on either side of the dorsal vessel.

The reproductive organs are upon the usual plan. Two pairs of sperm sacs lie in segments XI and XII. The two of each side of the body are connected by a sperm reservoir, which projects into the tenth segment, and encloses the funnels of the sperm ducts. The two sperm reservoirs seem to be quite distinct, and between them runs the nerve cord. Corresponding to the sperm sacs are two comparatively large egg sacs in the XIVth segment. The large size of these structures in *Perichaeta* is often noticeable; but they have not been recorded in all species. In *Perichaeta upoluensis* they are of an elongate pear-shaped form. The spermathecae (Fig. 8) are present to the number of two pairs lying in segments VIII and IX. Each has a single diverticulum, which is longer than the pouch of which it is an appendix. The diverticulum is plainly divided into a region for the storage of the sperm and a duct. The extreme end of the diverticulum is again divided by a constriction and is dilated; this however is possibly only a temporary condition caused by the presence in it of abundant sperm. The spermiducal gland lies in three segments in front of its external orifice. The duct is unprovided with a terminal sac.

PERICHAETA ESAFATAE, n. sp.

One example of this, which I regard as a new species, was collected on the island of Esafate in the New Hebrides. As there is but this one specimen, my account of the species will have to be less complete than is desirable.

The worm measures 115 mm. and consists of 105 segments.

The colour dorsally is purple.

The clitellum occupies the usual segments and is devoid of setae.

The most characteristic feature of this species, as is so often the case in the genus *Perichaeta*, is the arrangement of the genital papillae. These are numerous in

the neighbourhood of the male pores and suggest those of *Perichaeta papulosa*¹. The papillae are small sucker-like structures like those of *Perichaeta upoluensis*, not large flat papillae like those of *P. sedgwickii*. They have the following arrangement. On segment XVII are a pair lying side by side and close to the anterior boundary of the segment. Exactly corresponding to these in position are a pair on each of segments XVIII and XIX. On the border line of segments XVII and XVIII (this boundary line is not marked on the ventral side of the body) are two papillae on each side, and to the outside of, and wider apart from each other than are the median papillae already spoken of. Two papillae lie just to the inside of each male pore one above the other, and finally a papilla lies to the outside of and in line with the male pore.

The male pores are not near together; but there appear to be only four setae between them; these however do not occupy the entire space between those pores but lie in the middle of the area.

The gizzard has the form of a truncated cone, being narrower anteriorly than posteriorly. Caeca are present.

Two particularly strong septa follow the gizzard, enclosing between them the XIth segment.

The last hearts are in segment XIII.

The sperm sacs lying in XI, XII are unusually small, not very much larger indeed than the egg sacs in XIV. The spermiducal glands lie in segments XVII, XVIII, XIX; they are rather bean-shaped and not greatly broken up into lobes and lobules. From the hilum runs the short stout duct unprovided with any terminal sac. The spermathecae are two pairs in VIII and IX; the diverticulum is long and stout, and those of the anterior pair lie in the VIIth segment. The diverticulum has a distinct duct and is longer than the pouch.

PERICHAETA SOLOMONIS, n. sp.

Of this rather large new species of *Perichaeta* the collection contained two examples from Narowol, Solomon Islands, and a third specimen from Rubiana, New Georgia, Solomon Islands.

The species is of a rich brown colour, becoming purple on the dorsal surface anteriorly; whitish lines mark the implantation of the setae.

The largest specimen measures about 140 mm. in length by 9 mm. in greatest breadth; it consists of 90 segments.

The clitellum is not that of typical *Perichaetae*. In the larger specimen it embraces only half of the XIVth segment, the XVth and the XVIth. There is a complete circle of setae on segment XVI. In the second specimen from Narowol the clitellum is more restricted still; it occupies only half of XIV and the whole of XV.

The genital papillae (Fig. 1) are numerous and characteristic. But here again, as is so very usually the case; there is some variation from individual to individual. In all

¹ Rosa, I lombrichi raccolti in Sumatra, Ann. Mus. civ. Genova (2), xvi. p. 525.

specimens papillae exist near to the spermathecal pores as well as in the neighbourhood of the male pores. In the larger example, whose measurements are given above, the arrangement was this:—On segment XIX there are three papillae lying side by side in the middle of the segment, a little in front of the line of setae. In the two following segments there are, on each, five papillae, one on each side being added to the three of the XIXth segment. On the XXIInd segment only two of these five were visible, those on the outside (left side). The anterior sets of papillae lie on segments X, XI; on the Xth segment there is a row of four papillae and six on the XIth; these papillae lie in every case in front of the setae of their segments.

In the smaller individual from Narowol each of segments XIX—XXI has a symmetrical row of four papillae. Those upon segments X, XI are fewer and not symmetrical; there are three on the latter and four on the former.

In the specimen of *Perichaeta solomonis* from New Georgia, the disposition of the papillae was a little different. On each of segments XIX—XXII were four symmetrically placed papillae, save on the last of these segments where one was missing. There were also two or three papillae on segments X and XI.

The porophores bearing the male pores are very conspicuous in this species. They are much raised and of a whitish colour. The actual male pore is in the line of setae, and the two are separated by a line of fifteen setae. Anteriorly to each pore is a sucker-like papilla.

This is a stout and strong species of *Perichaeta*; corresponding to these characteristics the septa and the muscular development generally within the body-cavity is pronounced. Behind the gizzard are five rather stout septa which are to some extent tied together by muscular bands. From the posterior as well as from the anterior margin of the gizzard itself arise half a dozen broadish muscular bands which bind it to the following septum or to the body-wall. From the pharynx radiate out a large number of slips of muscle which for the most part perforate adjacent septa and are inserted on to the body-wall. It is interesting to notice that the septum separating segments VIII and IX is present and is indeed moderately stout. In so many cases this septum has been recorded as absent that there can be little doubt that it is not always represented; but in one or two species its existence has been mentioned by several authors. Benham, for example, has especially noted its presence in *Perichaeta arturi*¹. The bulk of the gizzard in *Perichaeta solomonis* lies in front of the septum and belongs therefore to segment VIII. I find in this species, as did Benham in *P. arturi*, a pair of hearts corresponding to this segment. The intestine has caeca.

The most noteworthy point about the vascular system that I observed was the fact that the last pair of hearts are in the XIIth segment and not, as is so generally the case, in segment XIII.

Perichaeta solomonis is also remarkable for the fact that it possesses three pairs of sperm-sacs instead of the more usual two. These lie in segments X—XII; they are large, and the first pair are racemose in appearance. The egg-sacs in the XIVth segment are large and conspicuous. The spermiducal glands (Fig. 6) are cut transversely into three lobes lying respectively in segments XVIII, XIX, XX; each lobe is again

¹ I also describe it here in *P. pacifica* (p. 191).

subdivided more coarsely and then more finely. The ultimate lobules are very minute. The duct of the gland, which is unprovided with a terminal sac, arises from the posterior margin of the anterior of the three lobes. The spermathecae (Fig. 5) are five pairs in segments V—IX. They are pear-shaped with a longish but narrow diverticulum which is about half the length of the pouch.

In the same tube which contained the worms from Narowol were a number of smaller worms, of which two were larger than the rest, and mature. In spite of the superficial likenesses of these to the ones that have just been described, I was at first disposed to place them in a different species on account of their smaller size. They are slender worms, the largest being 113 mm. long with a diameter of 3—4 mm. The number of segments in this specimen was 100. The colour is the same as in the typical *Perichaeta solomonis*. The genital papillae, however, differ in detail. But they present a general similarity of arrangement. In the larger of the two specimens now under consideration the papillae were fewer than in the smaller individual. In the latter are a pair of papillae on each of segments XVII—XIX, corresponding in position to the male pores. The XIXth has in addition a median papilla and on segment XVIII are a pair of such papillae.

On segment IX there are three median papillae. The clitellum is rather defective, occupying segments XIV—XVI, and setae are present on the first and last of these segments. The internal organs correspond in every detail to those of the typical *Perichaeta solomonis* save that the muscular bands tying the gizzard to the parietes are wanting.

Is this to be regarded as a dwarf variety which, on account of its small size, has not area sufficient for the development of the full complement of papillae? I am inclined not to take this view, and mainly for the following reasons. Among the smaller worms contained in the tube were two or three which I consider to be immature forms of the typical *Perichaeta solomonis*. It is of course impossible to be certain upon this point; their very immaturity is in the way of arriving at a definite conclusion. Now these presumed immature forms of the typical *Perichaeta solomonis* have the robust form of the type and not the slender form of the variety which I am now considering. There would seem therefore to be more difference between the two varieties than a mere precocious development of the sexual organs. Yet the close similarity of colour and the identity of internal structure must be borne in mind in coming to a conclusion. I am inclined to look upon these slender examples of the typical *Perichaeta solomonis* as individuals which represent a new species in the course of differentiation; the modification has advanced to a certain extent in certain of the external characteristics but has not yet touched the internal organs.

PERICHAETA PACIFICA, n. sp.

Dr Willey's collection contains a considerable number of examples of a small *Perichaeta* which I refer to a new species.

One of these specimens was much larger than the rest, which were all small.

This example measures 56 mm. in length and consists of some 90 segments; of the remaining specimens the largest was not more than 38 mm. in length. The smaller specimens were all collected on the banks of a rivulet in New Britain; the largest example bears the label "Gazelle Peninsula, New Britain."

This species of *Perichaeta* is coloured above of a bluish violet tint. My observations upon the species chiefly relate to some of the smaller specimens which I examined as to external characters as microscopical objects and by longitudinal sections. But the largest specimen was dissected and was found to differ in no point of importance that I could ascertain from the smaller individuals save in the number of the genital papillae. These papillae (Fig. 4) differ somewhat from individual to individual and the largest number were not present in the largest specimen. In that specimen their arrangement was as follows:—On each of segments XX—XXII there was a long transversely elongated papilla median in position and unpaired. In a smaller example the same papillae were present and in addition one upon each of segments XVII and XVIII as well as upon XII and XIII.

The clitellum occupies segments XIV—XVI; the last segment appears to always possess a complete circle of setae at the margin where the glandular development of the segment ends; in the large specimen the XVth segment also had a complete circle of setae. In a smaller individual mounted as a microscopic object I could see no setae upon the XVth segment; but in addition to those upon the XVIth were three setae on each side of the oviducal pore upon the XIVth.

In this latter specimen the setae upon a selected series of segments were present in the following numbers: VIII, 37; XIII, 47; XVII, 46.

There are in this specimen 10 setae between the male pores.

The septa dividing segments VII and VIII are thick; but those dividing segments IX and X are especially thickened. They are the thickest septa of all. Contrary to what is apparently sometimes found in this genus the septum between segments VIII and IX was present, though thin. In sections which did not embrace the gizzard this septum was seen to lie straight across the body-cavity and to bound a space—the coelom of the VIIIth segment—very much less than that bounded by the thick septum immediately following it. But in sections in which the gizzard was shown in position the septum was convex backwards so that the gizzard chiefly lies in the VIIIth segment.

Caeca are present. The last "hearts" are in segment XII.

The reproductive organs are mainly remarkable for the fact that there is but a single pair of testes, sperm ducts and sperm sacs. The testes lie together with the funnels lying opposite to them in a special sac, the sperm reservoir. The single pair of sperm sacs are in segment XII. They are racemose in appearance. The spermiducal glands extend through three segments, i.e. XVII—XIX. The duct is short and has no terminal sac. The spermathecae are present to the number of four pairs in segment VI—IX. Each has a single tubular diverticulum. It seemed to me that the sperm duct did not open into the duct of the spermiducal gland until a little way in front of the external aperture of the latter. Dr Benham has found the same state of affairs to characterise *P. malamaniensis* and quotes my own discovery of the union between the male duct and the duct of the spermiducal gland at a late point

in *P. perkinsi*¹. He suggests that this may not be an unusual occurrence in the genus *Perichaeta*. It is at any rate not universal, for I have examined from this point of view the Bermudan species *P. bermudensis* in which I find that the sperm ducts open into the duct of the spermiducal gland before it acquires its thick muscular coat.

The most salient structural feature of this *Perichaeta* is the presence of only a single pair of sperm sacs to which correspond but a single pair of testes and sperm ducts. Dr Rosa has pointed out that at present this character—the possession of only a single pair of sperm sacs—characterises nearly all the species of the genus from New Zealand. It is to be seen in *P. forbesi*, F. E. B., *P. neoguineensis*, Mich., and in *P. loriae* and *P. papua* of Rosa. In a specimen of *Perichaeta* however, not identified, from New Guinea, Rosa did not find that characteristic feature; that *Perichaeta* had the usual two pairs of sperm sacs. It is therefore important clearly to distinguish the present species, which is not widely separated in geographical range from any of those forms. It will be apparent I trust from the foregoing description that *Perichaeta pacifica* cannot be confounded with any of the above mentioned species. I imagine that it will be found when those species are more fully investigated that they will prove like *P. pacifica* to possess only a single pair of testes and funnels.

PONTODRILUS MATSUSHIMENSIS, Iizuka.

P. matsushimensis, Iizuka, Annotationes Zool. Japon. II., Pt. i., p. 21.

Dr Willey collected a large number of a species of *Pontodrilus* on the shore of the Isle of Pines which I identify with the above named species of the genus. That species is a native of the Japanese shores, having been met with there and described by Akira Iizuka. The fulness of Mr Iizuka's description renders it unnecessary for me to give an attempt at a complete account of the characters of the worm; but there are some points about the species which require a few notes.

The describer of the species does not comment upon the setae—as to whether they are or are not ornamented. This character is known to distinguish one species of the genus, viz. *P. bermudensis*². I do not find any ornamentation; for this reason and for the fact that the thickened septa extend from segments V to XIII, the present form from the Isle of Pines cannot be the same as *P. bermudensis*. In the latter species the thickened septa extend from segments IV to XI.

In my specimens however the clitellum is not quite so extensive as it is described to be by Iizuka. He states that it comprises segments XII—XVII; but in the plate it is represented as extending over segments XIII—XVII only (the oviducal pores being wrongly assigned to segment XIII). This is precisely what I found in Dr Willey's examples. Furthermore the oviducal pores lie a little to the inside and

¹ On some Earthworms from the Sandwich Islands, &c., P. Z. S., 1896, p. 200.

² *Pontodrilus arenae* of Michaelsen: Terricolen der Berliner Zoologischen Sammlung, Arch. f. Naturg., 1892.

of course in front of the innermost of the setae. Like the describer of the species I could find no setae near to the male pores; in that segment (the XVIIIth) the inner pair of setae are wanting.

Iizuka found that in this species the sperm ducts do not open at the junction between the muscular and glandular parts of the spermiducal gland. He remarks further that "the exact relation of the vas deferens and the spermiducal gland in *Pontodrilus* has probably never been subjected to careful examination by means of serial sections." I cannot recollect whether my own statement, which he quotes as part of the generic definition of the genus *Pontodrilus*, was based on actual examination; but I imagine that it was, since the figures of Perrier would naturally not be conclusive upon the point. In any case I have re-examined *Pontodrilus littoralis* and find that the sperm duct does join the spermiducal gland at the junction of the glandular part with the muscular duct. I endeavoured to ascertain how far *Pontodrilus hesperidum* agreed with the type species in this particular, but without effect. The variability in this matter is precisely analogous to that which is found in certain species of *Perichaeta* and which has been referred to above under the description of *Perichaeta pacifica*. In some the sperm duct joins the spermiducal gland higher up than in others. The fact is evidently of no great importance; but it is clear that it must be removed from the generic definition of *Pontodrilus*.

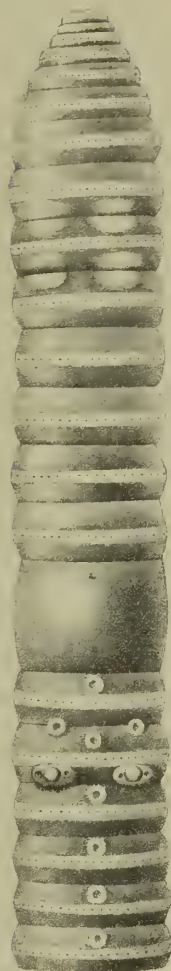
DESCRIPTION OF PLATE XXI.

- FIG. 1. *Perichaeta solomonis*: ventral surface of anterior segments.
„ 2. *Perichaeta upoluensis* „ „
„ 3. *Perichaeta sedgwickii* „ „
„ 4. *Perichaeta pacifica* „ „
„ 5. *P. solomonis*: spermatheca.
„ 6. „ spermiducal gland.
„ 7. *P. upoluensis*: spermiducal gland.
„ 8. „ spermatheca.
„ 9. *P. novae-britanniae*: ventral surface of segments XIII—XIX.

NOTE. To facilitate comparison it may be repeated here that the clitellum, in all the species figured, occupies segments XIV—XVI. The female orifice lies in the middle of segment XIV, and the paired male orifices occur on segment XVIII. One of the chief objects of the external views is to illustrate the appearance and distribution of the **copulatory papillae** which, as described in the text, are subject to considerable individual variation.



1



2



3



4



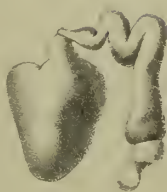
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7



5



8



9

BEDDARD. EARTHWORMS

Gilbert C. Phubb del

Edwin Wilson Cambridge.

THE GORGONACEA COLLECTED BY DR WILLEY.

By ISA L. HILES, B.Sc. (VICT.), OWENS COLLEGE, MANCHESTER.

With Plates XXII—XXIII.

THIS collection of Gorgonacea has proved a very interesting one, including several new forms. One new species has been added to that little known genus *Keroeides*; there is one new species each of *Acamptogorgia*; of *Acanthogorgia*; of *Villogorgia*; and of *Chrysogorgia*.

My thanks are due to Professor Bell for the trouble he took to help me in comparing some of the specimens with those in the National Collection.

Professor Hickson has very kindly given me much help, especially with regard to the literature bearing on the group. The classification adopted is that laid down by Wright and Studer in the Challenger Report on Alcyonaria (6).

SECTION. HOLAXONIA.

FAMILY. DASYGORGIDAE.

Sub-family. CHRYSOGORGIDAE.

Chrysogorgia constricta, n. sp. (Pl. XXII. Figs. 8, 9, 10.)

There is only one fragment of this species 205 mm. in length. It gives off two branches, one 75 mm. in length which bears a small lateral branchlet, and the other 70 mm. above the first and 43 mm. long. The stem is 1.5 mm. in diameter at the lowest point; the basal part is missing.

The axis is horny with calcareous particles scattered in broken rings. The coenenchyma is thin.

The polyps are large, directed obliquely upwards; they are distinctly divided into two regions by a constriction. The lower region measures 4 mm. high by 3 mm. in diameter where attached; the upper part measures 2.5 mm. by 1.5 mm. in diameter. The whole polyp is thus 6.5 mm. high. The polyps arise alternately on the two sides of the axis at intervals of 9 or 10 mm. The branches bear, close to the apex, two polyps, one slightly in advance of the other, and between them is a blunt projection, the actual apex of the branch.

The spicules are spindles with a few blunt spines. Some are long and broad and have only 1 or 2 spines, but these are rare. On the polyps they are arranged *en chevron* in 8 ascending rows, and the polyp is distinctly divided into 8 lobes which are continuations of the ridges formed by the rows of spicules. There are no spicules transversely arranged either in the upper or the lower part of the polyp. The colour in spirit is white. The axis is yellow.

This species differs from *Chrysogorgia desbonni*, Duchassaing and Michelotti (1), in the position and shape of the calyces and in the arrangement of the spicules in the lower portion of the calyces, where they are not transversely placed. It differs in the same point from *Chrysogorgia fewkesii*, Verrill (3).

Habitat. Talili Bay, New Britain.

FAMILY. ISIDAE.

Sub-family. MOPSEINAE.

Primnoisis ambigua, Wright and Studer. (Pl. XXII. Fig. 11.)

Only two very small colonies have been preserved. The axis shows fairly short, calcareous joints, cylindrical and longitudinally fluted.

The ends of the twigs are formed by a short, calcareous joint.

In the stem and branches the calcareous joints are 2.2 mm. in length and the horny joints .12 mm. Thus both are much smaller than in the Challenger specimen. But the calcareous joints are larger in proportion than the horny joints.

The diameter of the axis is .2 mm.

The branches are given off from the calcareous joints, but rather irregularly, some of the joints bearing no branches. They spring from a small, calcareous projection, followed by a horny joint.

The spicules are longish, with strongly toothed edges. In the calyces the spicules are transversely placed, with sharp teeth on the margin which interlock with those of the next plate.

The spicules vary in size, some being .18 mm. long $\times$.13 mm. in diameter, others .16 $\times$.08 mm., and others again .12 $\times$.02 mm.

The spicules are therefore somewhat smaller than those of the type specimen, Wright and Studer (6), which measure .28 $\times$.1 mm.—.17 $\times$.05 mm.

The coenenchyma is thin and transparent and preserved only in patches.

The club-shaped polyps are fairly numerous on the twigs and directed obliquely upwards; they measure .6—7 mm. in height and are about .6 mm. apart. In the type specimen they are .8—1 mm. high.

The calcareous and horny joints in the specimen in the Challenger collection measure 2.5—4 mm. and .5—1 mm. respectively. Thus the proportionate lengths differ.

These fragments differ from the type specimen in three small points of measurement, differences which are not of sufficient importance to justify a new species.

Habitat. Sandal Bay, Lifu.

Previously recorded from Kerguelen Island. Depth, 10—80 fathoms.

FAMILY. MURICEIDAE.

Acamptogorgia acanthostoma, Germanos.

This fragment agrees with Germanos' description (8) of a colony from Ternate except as regards the colour, which is not whitish but greyish brown.

The centre of the axis is divided into chambers and many of the chambers contain calcareous matter in the form of irregular lumps.

The spicules are decidedly larger than in the form described by Germanos, in which they measure $\cdot 15$ mm. and $\cdot 25$ mm. In this form on the average they measure $\cdot 5 \times \cdot 4$ mm. Otherwise it agrees with Germanos' description and excellent figures.

Habitat. Milne Bay, British New Guinea. About 20 fathoms.

Previously recorded from Ternate.

Acamptogorgia spinosa, Hiles¹.

The specimens consist of two fragments, the larger of which measures 95 mm. in height and 70 mm. across the broadest part. It is evidently only the fragment of a larger colony, as there is no basal part and no branch which could be called the main stem. The thickest branches measure $\cdot 5$ mm. in diameter. It resembles the specimen *Acamptogorgia spinosa* from Funafuti except that it is somewhat darker in colour and larger generally. This may be due to the specimens being fragments from an older colony. The calyx spicules also project slightly further.

*Measurements.**Funafuti specimen.**These fragments.*

Polyps.	$\cdot 73$ mm. high.	$\cdot 83$ mm. high.
"	$\cdot 55$ mm. in diameter at the base.	$\cdot 86$ mm. at the base.
Opercular spicules.	$\cdot 36$ mm. $\times \cdot 09$ mm.	$\cdot 55$ mm. $\times \cdot 18$ mm.
Polyp spicules.	$\cdot 37$ mm. $\times \cdot 36$ mm.	$\cdot 66$ mm. $\times \cdot 44$ mm.
Coenenchyma spicules.	$\cdot 11$ mm. $\times \cdot 31$ mm.	$\cdot 36$ mm. $\times \cdot 47$ mm.

The spicules are thus larger; still these differences do not seem to justify making a new species. Both forms are from the same depth.

Habitat. Blanche Bay, New Britain. 40 fathoms.

Recorded from Funafuti, Ellice Islands.

Acamptogorgia tuberculata, n. sp. (Pl. XXII. Figs. 1 and 2.)

There is one small colony of this species. The main stem is 32 mm. in height by 1.4 mm. in diameter near the base.

It gives off branches on the two sides in the same plane, 6 branches altogether. Three of these bear each a lateral branch.

The longest branch is 20 mm. in length. The polyps are closely placed on three sides of the stem and branches, leaving the back of the branches free.

¹ My account of the Gorgonacea collected by Mr J. Stanley Gardiner in Funafuti will be presented to the Zoological Society on January 17th, 1899.

Each branch bears at the apex two laterally placed polyps.

The polyps are low and cylindrical in shape; they measure 1.5 mm. by 1.4 mm.

The axis is horny, brown in the older parts, white at the apices.

The coenenchyma is fairly thin and both it and the calyces are very rough, looking "lumpy" owing to the projecting foliar expansions of the spicules.

The operculum is low and conical.

The spicules of the coenenchyma and polyps are alike; they are slightly bent spindles, with spiny warts along one side, and on the convex side at one end or about the middle arise complex foliar prominences. They measure $.51 \times .18$ mm., $.36 \times .33$ mm., $.42 \times .14$ mm.; the foliar expansion measures about $.18-.25 \times .16$ mm.

The spicules of the collaret are curved spindles with a few spines; they measure $.27 \times .034$ mm.

The opercular spicules are flat, spiny, more pointed at one end than the other; they measure $.30 \times .054$ mm. There are eight groups of three spicules.

The spicules are all colourless.

The coenenchyma and polyps are white.

The spicules resemble closely in form and in size those of *A. fruticosa*, Germanos, from Ternate, but that species is dark red in colour.

But the polyp calyces are much larger than those of *A. fruticosa*, and the surface of the colony is more closely crowded with prominences from the spicules, hence I have suggested the name of *Acamptogorgia tuberculata*.

Acanthogorgia spinosa, n. sp. (Pl. XXII. Figs. 3—6.)

There are four fragments, the largest of which measures 135 mm. long and is evidently only the end of a branch. It bears three branches on one side of the axis, at intervals of 20 and 35 mm., and one in a plane at right angles to the others at a further interval of 46 mm. and within 35 mm. of the tip.

Two of these branches bear each a small branch of the third order.

The main branch measures 2 mm. in diameter at the lower end.

The coenenchyma is thin and fairly smooth.

The axis is horny and brown in colour.

The polyps arise from all sides of the stem and branches, and are closely crowded together. The apices of the branch and twigs are occupied by a polyp.

In shape the polyps are elongated, cylindrical and somewhat expanded at the summit. They are placed perpendicularly on the branches; they measure from 3—4 mm. in length, .9 mm. in breadth at the base, and 1.3 mm. across the crown. The polyps are thickly crowded round the branches.

The spicules of the coenenchyma are chiefly of the quadri-radiate type, measuring $.26 \times .16$ mm., but longish spindles with small scattered spines, measuring $.7 \times .07-.11 \times .01$ mm. length by breadth, also occur.

In the polyps the spicules form eight longitudinal rows; each consists of two sets of spicules arranged *en chevron*, which are continued to the bases of the tentacles.

At the top of these rows are the long bundles of spicules (each consisting of

2 or 3 needles) which project above the polyp head for some distance, having only a small portion of the lower end embedded in the calyx.

These spicules are all of the same type—spindles—bent at the lower end which bears only a few, scattered, small spines in the projecting spicules, those of the calyx-wall being more or less covered with them.

The projecting spicules measure 1.4 mm. $\times$.1 mm.; those of the polyp-wall measure .5 $\times$.04 mm.

The colour in alcohol is dirty white.

This form seems closely allied to *Acanthogorgia muricata*, Verrill, from Nova Scotia. In the size of the calyces it approaches more nearly *A. muricata*, Verrill, from the Barbadoes, where they are about 3 mm. high.

The only apparent difference from *A. muricata* is that there are 8 projecting groups of 2 or 3 spindles, while in *A. muricata* there are 8 single spicules; this is quite a sufficient distinction for a new species.

Habitat. Mouth of Blanche Bay, New Britain. Depth, 25 fathoms.

Villogorgia intricata, Gray.

The specimen is somewhat larger than that described in the Challenger Collection.

The base of the colony is missing, but the height of the portion present is 150 mm.; the width is about the same, but the colony is evidently imperfect.

The main branches measure 1 mm. in thickness and reach to the top of the colony.

The polyps are irregularly scattered round the stem at intervals of approximately 1 mm. They measure .48 mm. in height, by .55 mm. in breadth, thus agreeing with those of the Challenger specimen.

The spicules of the coenenchyma are 4-rayed stars, and spindles branched on one side.

The axis is horny, flexible, the centre hollow and divided into horizontal chambers; in some parts of the stem these are filled with calcareous matter in the form of irregular lumps.

The axis is light yellow in colour and the colony in spirits is brownish.

Habitat. Sandal Bay, Lifu. Depth 30 to 40 fathoms.

Previously recorded from Bass Straits, Fiji, and the New Hebrides.

Epizoid on this form are several specimens of an Ophiuroid which corresponds fairly well to *Astroschema koehleri*, Döderlein (10); the only differences are in the length of the arms in proportion to the width of the disc, which in these forms is as 12 mm. to 1.5 mm., and in Dr Döderlein's as 10.6 mm. to 2.3 mm., also the rings of warts on the upper surface of the arms are not apparent.

There are also specimens of the Mollusc *Avicula hirundo* attached to the colony.

Villogorgia rubra, Hiles.

There is one specimen which resembles closely the new species, *Villogorgia rubra*, described by me in the collection of Gorgonidae from Funafuti, Ellice Islands¹.

¹ See footnote on p. 197.

The colony is upright and richly branched in one plane. The base is missing and the colony has the terminal branches somewhat broken.

The branches arise from both sides of the stem at an angle of from 80° — 90° . The lateral twigs of the branches arise fairly perpendicularly.

Some bend after a short distance and run parallel with the parent branch.

The height of the colony is 70 mm., the greatest breadth 60 mm. The thickness of the principal stem at the base is 1 mm. The coenenchyma is thin.

On the branches the polyps are about 1 mm. apart, but on the main stem they are not so closely placed, being often 2 mm. apart. They are perpendicularly placed, chiefly on two sides of the stem and branches.

Habitat. Sandal Bay, Lifu.

Villogorgia compressa, n. sp. (Pl. XXII. Fig. 7.)

There is one very fine colony and one smaller piece.

The large colony measures 490 mm. high and 540 mm. across the broadest part; the basal part is missing.

The colony is richly branched in one plane, the branches springing from both sides of the stem at angles of from 80° — 90° .

There are numerous anastomoses of big and small branches.

The thickest branches are almost ribbon-like, being flattened at right angles to the plane of branching. They measure 3 mm. by 1 mm. in diameter. The coenenchyma is thin.

The polyps are perpendicular to the stems and branches; they are rather less frequent on one face of the branches than the other.

They are fairly thick on the terminal branches, but elsewhere they occur at intervals of from 1—2 mm.

There are two polyps at the end of each branch, neither terminal.

They measure 1.2—1 mm. in height by 1.05—0.83 mm. in breadth across the crown.

The spicules are of the *Villogorgia* type (6) and measure:—the stellate forms of the cortex—.15 mm. by .036 mm. (width of the main portion) and .027 mm. (width of the base of the rays); the fusiform spicules of the cortex—.55 mm. $\times$.05 mm.; the opercular spicules—.36 mm. $\times$.05 mm.; the polyp spicules—.4 mm. $\times$.17 mm.

These are maximum measurements in all cases.

The operculum is of the *Villogorgia* type.

The axis is horny, flexible, with the central core chambered.

The colour of the colony in spirit is dirty brown¹. The spicules are colourless.

This form differs from *V. intricata* in its size, being larger, and in the greater roughness of its appearance.

It differs from *V. flabellata* in form and in its spicules, from *V. mauritiensis* in the shape of the spicules, and from *V. nigrescens* in the size, &c. of the verrucae.

Habitat. Blanche Bay, New Britain. Depth, 50 fathoms.

¹ In fresh condition the prevailing colour was pink due to the coloured zooids; the coenosarc had a brownish neutral tint.

SECTION. SCLERAXONIA.

FAMILY. SCLEROGORGIDAE.

Keroeides gracilis, Whitelegge. (Pl. XXII. Figs. 12—14.)

Only a few fragments of this form have been found. The largest closely approximates to that described by Whitelegge (9).

The verrucae alternate on the sides of the stem and branches. They are low and conical in shape, measuring 1 mm. in height and the same in diameter at the base.

On the main stem they are about 3 mm. apart, on the branches 1—2 mm. apart.

The coenenchyma is thin, smooth and filled with large, closely packed, compound tuberculated spindles.

The axis consists of a number of long, closely-set spicules cemented together round a horny central strand and agrees in diameter with the type specimen.

The irregularity in the shape of the coenenchyma spicules near the verrucae is not so apparent as Whitelegge describes it.

The spicules are pale pink in colour by transmitted light.

They are .84 mm. long and .27 mm. wide.

The small tentacular spicules are .11 × .04 mm. and the spicules of the axis are .22 × .02 mm.

Thus all the spicules are somewhat smaller than in *K. gracilis*, Whitelegge, where they are 1 × .15 mm.—2 × .3 mm.

The colour of the colony also differs from that of *K. gracilis*, being pale pink instead of coral red; but they are both shallow water-forms.

I do not consider that these small points of difference are sufficient for characterising a new species, especially as there are only a few fragments of the specimen and no complete colony.

Habitat. Milne Bay, British New Guinea. Depth 20 fathoms.

Previously recorded from Funafuti, Ellice Islands.

Keroeides pallida, n. sp. (Pl. XXII. Figs. 15 and 16.)

There is one fairly complete specimen showing the basal attachment, and three fragments. The largest piece measures 130 mm. in height and 140 mm. across the widest part of the colony. The diameter of the main stem near the base is 4.0 mm. by 2.5 mm., and of the terminal branches 2.0 mm. by 1.0 mm. Thus both stem and branches are somewhat flattened. The main stem is broken off at a height of 85 mm. from the base.

The main stem gives off five branches in one plane at an angle of about 60°. They soon turn upwards and run parallel to the main stem. Each in its turn bears two or three branches, some of which also bear branchlets. The branches end in two polyps. Originally the branching must have been in one plane; the curving inwards seems to be due to the position in the bottle of spirit.

The polyps are borne chiefly on the two sides, and, as a rule, alternately.

The verrucae are cylindrical in shape; in no case has the polyp completely retracted, the tentacles being visible.

The verrucae measure 1.5—2.0 mm. in height, and 1.5 mm. in diameter at the base. They are about 3 mm. apart.

The coenenchyma is thin and smooth, being filled with closely packed, multi-tuberculate spindles. The spicules are all colourless.

The axis is sclerogorgic; dark brown in colour in the main stem and lighter brown in the branches.

The base of the colony consists of a flat, spreading disc.

The spicules measure 1.06 mm. $\times$.27 mm. to .24 mm. $\times$.04 mm.

The tentacular spicules measure .23 mm. $\times$.03 mm. The spicules of the axis measure .46 mm. $\times$.24 mm.

The colony is pale fawn in colour.

The spicules resemble those of *Keroeides koreni*, Wright and Studer (6), from the Hyalonema ground off Japan, but the colour, size and general appearance of the colony separate the two forms. It differs also in the same features from *K. gracilis*, Whitelegge.

Habitat. Talili Bay, New Britain. Dredged in 30 fathoms.

FAMILY. GORGONELLIDAE.

Verrucella guadalupensis, Duchassaing and Michelotti. (Pl. XXIII. Figs. 1, 2.)

There is one large specimen and several small pieces which may be fragments of the large colony.

It is much branched in one plane, the branching being irregular, sometimes opposite but generally alternate.

The colony measures 310 mm. in height and the main stem is 3.5 mm. thick at the base.

The colony was attached by a calcareous enlargement at the base.

The main stem gives off numerous thick branches, slightly less in diameter than the stem itself at the point of branching. Between these branches are numerous small twigs.

Each branch bears branches of the second order, which give off branches of the third order, and so on up to the fifth order. Anastomoses occur fairly frequently even between branches of the first order.

All the branches arise at angles of about 60°. The axis is hard, lamellar, calcified; it is pale yellow in colour.

The cortex is thin, smooth and friable, whitish in colour and appearing granulated under the lens.

There is no terminal polyp, the branches bearing two lateral, opposite polyps close to the end.

The verrucae are small and wart-like and are borne on all sides of the lower part of the main stem at fairly large intervals.

On the upper part of the stem and on the branches they are borne chiefly laterally and alternately.

They measure .36 to .64 mm. in height, and .5 mm. in breadth.

The terminal ones are usually large, measuring .92 mm. by 1.01 mm. at the base. They are smooth, like the rest of the coenenchyma, and divided into eight rays at the summit, which are folded over the retracted polyps.

The spicules are double clubs and double spindles with irregular rings of tubercles and a bare zone in the centre.

Some are pointed at the ends and some are rounded. There are a few double stars.

The spicules are colourless.

The pointed spicules measure $.11 \times .018$ mm.

Those with rounded ends measure $.08 \times .036$ mm.

The double stars measure $.046 \times .018$ mm.

The colony is pale fawn in colour in spirit. When alive it was pure white.

Habitat. Blanche Bay, New Britain. Depth, 50 fathoms.

Previously recorded from the West Indies. It is a noteworthy point in geographical distribution, that the same species of *Verrucella* should be found both in the West Indies and at a depth of 50 fathoms in Blanche Bay, New Britain.

Commensal with this species of *Verrucella* is a large number of Anemones, belonging apparently to the tribe Hexactiniae, family Amphianthidae Hertwig, all the members of which are attached to Gorgonidae.

The circular muscle, i.e. the sphincter, is mesogloal and very powerful.

It is not a *Stephanactis*, as there is no circular swelling dividing the animal into an upper and a lower section, and the tentacles are not numerous, but the animals are all in such a strong state of contraction that it is impossible to accurately tell their number or arrangement.

It is not an *Amphianthus*, as the wall is not covered with papillae.

It agrees most closely with *Gephyra dornii*, v. Koch; the two forms are of the same size, 1.5 mm. in diameter at the base and 1 to 1.5 mm. in height. But the tentacles are less numerous, seeming to be in two rows of 18. Von Koch describes a secretion of horny matter of which I see no trace in this form. Thus the specimens do not seem to belong to any of the three known genera of the Amphianthidae. The characters, as far as it is possible to make them out owing to the strongly contracted condition, are:—

Amphianthidae with a firm, smooth wall and a strong circular muscle, mesogloal in position; the tentacles¹ are apparently in two rows of 18. There is no circular swelling.

Provisionally the name of *Peronanthus*² *verrucellae* might be given to these commensal anemones.

¹ The tentacles, if they can be so called, were quite obscure in the fresh condition and the Anthozoid bore an external resemblance to a Scyphistoma. The colour was reddish yellow. [Ed.]

² *περόνη* a brooch, and *ἄνθος* a flower.

FAMILY. MELITODIDAE.

Melitodes ochracea, Lamouroux.

There are specimens in three separate bottles, two fairly large colonies, and several fragments.

One of the larger ones measures 290 mm. high; the main stem at the lowest horny joint measures 8 mm., and the calcareous joint above it measures 3 mm.

The other colony is 260 mm. in height.

The colony is dark red in colour, smooth and showing marked jointing of the axis, as the measurements show.

The polyps, which are fairly well expanded, are green in colour.

Habitat. Talili Bay, New Britain.

Previously recorded from Singapore. Numerous specimens have been referred to in various publications, but unfortunately localities are not given.

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EXPLANATION OF PLATES XXII. AND XXIII.

PLATE XXII.

(Most of the drawings for this plate were made by the author.)

- FIG. 1. *Acamptogorgia tuberculata*, n. sp. Colony. $\times 2$.
 FIG. 2. Spicules of same.
 FIG. 3. *Acanthogorgia spinosa*, n. sp. Polyp-head.
 FIG. 4. Spicules of same; (a) of the operculum, (b) of the polyp, (c) of the coenenchyma.
 FIG. 5. *Acanthogorgia spinosa*. End of branch of a decalcified portion of colony. $\times 3$.
 FIG. 6. Polyp of same showing spicular tracts.
 FIG. 7. *Villogorgia compressa*, n. sp. Spicules (a) of the operculum, (b) of the coenenchyma, (c) of the polyp.
 FIG. 8. *Chrysogorgia constricta*, n. sp. A branch. $\times 2$.
 FIG. 9. Same. Two terminal polyps. $\times 12$.
 At the base is a young polyp not yet fully developed.
 FIG. 10. Same. Spicules.
 FIG. 11. *Primnoisis ambigua*. Spicules.
 FIG. 12. *Keroeides gracilis*. Portion of branch showing arrangement of spicules.
 FIG. 13. Same. Spicules of the coenenchyma.
 FIG. 14. Same. Part of the sclerogorgic axis.
 FIG. 15. *Keroeides pallida*, n. sp. The end of a branch showing arrangement of spicules.
 FIG. 16. Same. Spicules (a) of the coenenchyma, (b) of the polyp.

PLATE XXIII.

- FIG. 1. *Verrucella guadalupensis*. Part of the Colony. $\times 2\frac{1}{2}$.
 FIG. 2. *Verrucella guadalupensis*. A branch, $\times 4$, showing the manner in which the branches give support to the anemones, *Peronanthus verrucellae*, n. gen. et sp.



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HILES. GORGONACEA

PART I., published in August 1898, price 12s. 6d., contained the following Contributions :—

	PAGE
1. The anatomy and development of <i>Peripatus novae-britanniae</i> .	1
By ARTHUR WILLEY, M.A., D.Sc.	
With Plates I.—IV. and 7 figures in the text.	
2. <i>Metaprotella sandalensis</i> , n. sp. [Caprellidae]	53
By DR PAUL MAYER.	
With 6 figures in the text.	
3. On a little-known sea-snake from the South Pacific	57
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4. Report on the Centipedes and Millipedes	59
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5. Account of the Phasmidae with notes on the eggs	75
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With Plates VII.—IX.	
6. Scorpions, Pedipalpi and Spiders	95
By R. I. POCKOCK.	
With Plates X.—XI.	

PART III. (now in the Press) will contain

Orthogenetic Variations in Chelonia.

By HANS GADOW, M.A., PH.D., F.R.S.

Report on Crustacea-Macrura.

By L. A. BORRADAILE, M.A.

Anatomy of Coenopsammia.

By J. S. GARDINER, M.A.

Report on the Echiuroidea.

By ARTHUR E. SHIPLEY, M.A.

Enteropneusta from the South Pacific, with notes on the West Indian Species.

By ARTHUR WILLEY, M.A., D.Sc.



